ICT Project Opportunities in Argentina, Brazil and Paraguay

A Resource Guide for U.S. Industry

USTDA

U.S. TRADE AND DEVELOPMENT AGENCY

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The U.S. Trade and Development Agency

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development Projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding Project planning activities, pilot Projects, and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries.

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1 INTRODUCTION

The U.S. Trade and Development Agency (USTDA) helps companies create U.S. jobs by exporting U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries.

This guide provides U.S. companies and exporters an overview of infrastructure projects across the information and communications sector in several Southern Cone countries, Argentina, Brazil, and Paraguay, primarily over the next three years. Each of the countries and selected ICT project opportunities are profiled following. ICT Sector Overviews are provided in an Annex at the end of the Resource Guide.

Currency amounts are converted from local currencies to United States Dollars (USD) based on the current exchange rate when preparing this guide. Due to fluctuations in currency values, accuracy levels for engineering and cost estimates for different projects, and various timing of cost information publication, this report's monetary values should be considered approximate. Unless explicitly indicated otherwise, all currency values are in United States Dollars (USD).

1.1 Regional ICT Development

From an ICT development perspective, the three countries covered in this Resource Guide, Argentina, Brazil, and Paraguay, are mostly at or above world levels in terms of telephone, internet, and broadband service usage on per capita bases. Argentina has more mobile telephone subscriptions per capita than the United States, but all still lag the U.S. in fixed broadband. Each country has a current government digital agenda (ICT strategic plan) to ensure its capabilities allow ongoing global interaction and competitiveness. Most ICT sub-segments host private enterprises in the three countries, although the governments still control select elements.

The Latin American/Caribbean region, in total, represents approximately seven percent of the global ICT market and is generally growing faster than world averages. Within the region, Brazil is the largest ICT market, with an estimated three percent global share.

None of these countries has a strong ICT goods export position. All are significant importers of ICT goods and services, with ICT goods imports, alone, representing eight to ten percent of all imports. Therefore, current supply opportunities for U.S. ICT technology providers are attractive.

The remainder of this Resource Guide defines specific sector opportunities relevant to U.S. exporters for the three countries.

1.2 Authors

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1.3 Acknowledgements

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2 ARGENTINA

2.1 ICT Demographics

Argentina is a coastal South American nation, the continent's second-largest, with nearly 5,000 km of shoreline. As a result, the country is strategically located between south Atlantic and Pacific sea shipping lanes and can access large-capacity, subsea fiber optic trunk lines. Argentina is the eighth-largest nation globally at 2,736 square km, equivalent to roughly 30 percent of U.S. landmass, requiring a variety of ICT solutions to provide connectivity throughout the nation.

The majority of the Argentine population of 44.5 million lives in urban areas, with about one-third residing in or near the capital and largest city, Buenos Aires. Population density is highest in the country's northern and central portions, with Patagonia in the south sparsely populated. The next largest cities of Cordoba and Rosario are home to 1.4 and 1.1 million, respectively, with another fifteen cities each hosting 250 to 875 thousand inhabitants.[1] The variations in population density require an array of communication network designs.

2.2 ICT Sector Development

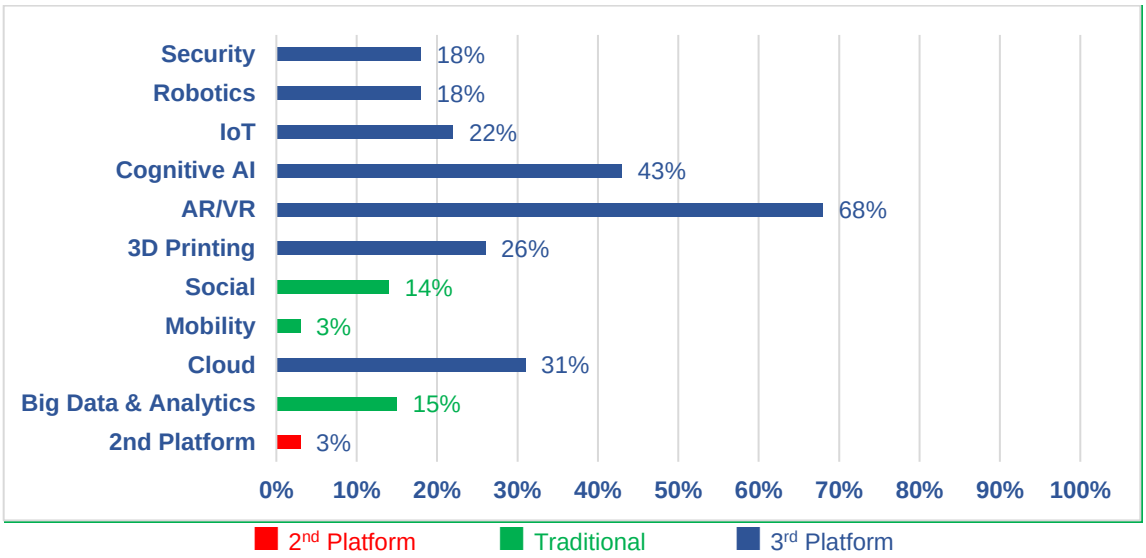
Argentina's existing ICT sector, as measured by telephone, internet, and fixed broadband access, meets or exceeds median world levels. Argentina is 20th and 26th in the world in terms of total fixed broadband and mobile cellular subscriptions, respectively, while it stands at 64th and 28th globally, on a population-adjusted basis[2]. Urban populations comprise over 92 percent of citizens to be served by ICT infrastructure in Argentina.

Growth rates for advanced ICT technologies in Argentina are projected to be strong, while more basic sectors (e.g., mobility and basic internet) are lower due to saturation (*Figure 1*).
A multi-ministerial committee, Consejo de Planificación y Seguimiento de la Agenda Digital, has undertaken "Digital Agenda 2030" as of November 2018. The Agenda focuses on:

- Regulatory framework;
- Infrastructure;
- Education and digital inclusion;
- Digital economy; and
- Digital government.

[1] Worldometers
[2] International Telecommunications Union

Figure 1: ICT Sector Projected Growth, 2019-2020 - Argentina[3]



Other ICT-related government programs include:

- National Telehealth Program, 2018-2024 (Government Secretary for Health),
- National Artificial Intelligence Plan (Ministry of Science, Technology, and Innovation),
- Third telecommunications satellite to expand internet access throughout Argentina (ARSAT), and
- Support of 5G trials (with Huawei).

Several plans and projects to enhance the Argentine ICT industry in conjunction with the United Nations International Telecommunication Union (ITU), have been completed from 2004 to 2018.

2.3 Regulatory Landscape

The principal telecommunications regulator in Argentina is Ente Nacional de Comunicaciones (ENACOM), created by presidential decree in 2016 to combine the former Federal Authority for Audiovisual Communication Services (AFSCA) and the Federal Authority for Information and Communications Technologies (AFTIC). ENACOM also regulates Argentina Soluciones Satelitales S.A. (ARSAT), the national communications satellite company, and Correo Argentina (CORASA), the postal service, which operates under the auspices of several government ministries. ENACOM oversees all telecommunications licenses, license durations, and transfers.

Argentina has one of the highest broadband penetration rates in the region, supported by private operators and the government. The country's major communications networks are digital, and it has continually improved telephone service to rural areas. Despite this, there is still limited competition for broadband and mobile telephone services.

[3] IDC

The government owns and operates one television station and radio network, and there are two dozen privately-owned TV and hundreds of privately-owned radio stations. The country has a high rate of cable TV subscribers.

2.4 ICT Sectors Profiled

While the Argentine ICT sector is well developed for the region, investment and further development opportunities exist across all segments. Public and private initiatives are in development across communications networks, subsea and satellite connectivity, data centers, artificial intelligence (AI), Internet of Things (IoT), and digital healthcare.

This Resource Guide reviews Argentine ICT development projects spanning four ICT subsectors relevant to the projects presented:

- Satellites
- Smart Cities and e-Government
- Internet of Things (IoT)/Artificial Intelligence (AI)
- Digital Healthcare

2.4.1 Satellites

Communications satellites are an important component of global ICT infrastructure, allowing transmission of large amounts of data over wide geographic areas without the need for land- or sea-based cabling. Satellites are useful in the Latin America and Caribbean region to provide communications access for portions of the population in remote geographic areas where cabling may not be economic.

Argentina currently has 22 satellites in orbit (*Table 1*). The NuSat class comprises earth observational satellites, as is the first SaoCom satellite (with another expected to be launched soon). The CubeBug group includes primarily technology development and demonstration satellites. The ARSAT group comprises communication satellites. Since typical satellite lifetimes are in the range of 10 to 15 years for GEO and about five years for LEO satellites, those launched before 2010 are likely not operational.

In 2006, Argentina created, by federal law, ARSAT SA, a company given the right to explore the 81 degrees West orbital slot and mandated to build in the country and operate one or more communications satellites. ARSAT launched its first satellite, ARSAT-1, in October of 2014, from French Guiana. ARSAT-1 is a geostationary Ku band satellite with a payload of 350kg. ARSAT-1 is expected to remain operational through 2033.

Table 1: Argentina Satellites in Orbit, 2020[4]

Name	NORAD ID	International Code	Launch Date
NUSAT-8 (MARIE)	45018	2020-003C	January 15, 2020
NUSAT-7 (SOPHIE)	45017	2020-003B	January 15, 2020
SAOCOM 1-A	43641	2018-076A	October 8, 2018
NUSAT 5	43204	2018-015K	February 2, 2018
NUSAT 4	43195	2018-015D	February 2, 2018
NUSAT 3	42760	2017-034C	June 15, 2017
NUSAT 2 (BATATA)	41558	2016-033C	May 30, 2016
NUSAT 1 (FRESCO)	41557	2016-033B	May 30, 2016
ARSAT 2	40941	2015-054B	September 30, 2015
ARSAT 1	40272	2014-062B	October 16, 2014
BUGSAT 1	40014	2014-033E	June 19, 2014
CUBEBUG 2	39440	2013-066AA	November 21, 2013
CUBEBUG 1	39153	2013-018D	April 26, 2013
SAC-D (AQUARIUS)	37673	2011-024A	June 10, 2011
PENHUESAT 1	29712	2007-001D	January 10, 2007
LATINSAT A	27612	2002-058H	December 20, 2002
LATINSAT B	27606	2002-058B	December 20, 2002
SAC C	26620	2000-075B	November 21, 2000
NAHUEL 1A	24714	1997-002B	January 30, 1997
OSCAR 19 (LUSAT)	20442	1990-005G	January 22, 1990
NAHUEL I1 (ANIKC1)	15642	1985-028B	April 12, 1985
NAHUEL I2 (ANIKC2)	14133	1983-0559B	June 18, 1983

ARSAT-2, also a geostationary satellite, built by the Argentine company, INVAP, was launched from French Guiana during September 2015. Structurally and mechanically, it is a copy of ARSAT-1 except for payload, necessitating rearrangement of the antennae configuration. ARSAT-2 includes both Ku and C band sections.

ARSAT is currently developing ARSAT Second Generation-1 (ARSAT SG-1, formerly known as ARSAT-3). Like its predecessors, this satellite will orbit at the 81 degrees West geostationary slot. New technology updates, however, will include high-throughput Ka band capability (12 Ku-band and 8 Ka-band operative transponders). Argentina initiated this project in 2015, but a lack of funding due to insufficient capacity utilization of ARSAT-2 stalled the project. The Argentine administration elected in December 2019 has agreed to finance the project, with ARSAT SG-1 to be launched in 2023. Its operative lifetime will be 15 years.

[4] N2YO.com

2.4.2 Smart Cities and e-Government

Smart cities are municipalities with a high level of digitization for serving the citizenry. Smart city applications include smart street lighting, transportation and traffic management, security, weather and natural disaster reporting, public WiFi access, citizen apps for management and payment of governmental licenses and fees, and numerous other areas where digitization improves access, efficiency and economics.

The global Smart Cities business opportunity is estimated to reach $2 trillion by 2025[5]. The Latin American/Caribbean region represents approximately 10 percent of the global Smart Cities business. The public sector generally owns smart-cities applications, while the majority of required initial investment arises from the private sector.[6]

In Argentina, Buenos Aires began focusing on using modern approaches to address issues in Public Administration as early as 2008. At the time, paper records resulted in citizen issues and complaints (of which 30,000 per month were typical) going unanswered for as long as eighteen months. Using a digital approach, the city is now able to establish priorities in nearly real-time, as well as address issues within a maximum of 96 hours.

Another early issue in the Buenos Aires Smart City journey was city safety. To address this, as well as better manage energy consumption, Buenos Aires initiated a smart street lighting effort, a typical, early Smart Cities project. By converting its 91,000 streetlights to a digital LED system, the municipality now gets real-time information concerning power outages, broken lights, and vandalism. The city can also track contractor performance, and installation and maintenance costs.

Other Smart City and e-Government initiatives in the Argentine capital city have included:

- Smart pipe system to manage drainage and flooding, as well as enhance associated service planning and repair truck deployment. This system is also capable of providing citizen weather alerts predicting flooding.
- Security – including various sensors and digital reporting systems.
- Transportation - including a smart card electronic ticketing system for public transit.
- Education – including the provision of student laptops.
- Healthcare – including telehealth access.

Beyond Buenos, Aires, eight Argentine cities are members of the Open and Agile Smart Cities (OASC) network, a global network connecting 150 smart cities in 30 countries:

- Ameghino;
- Berisso;
- Carlos Casares;
- Coronel Suarez;
- La Plata;

[5] Frost & Sullivan
[6] McKinsey and Company

- Lobos;
- Ramallo; and
- Puan.

La Plata serves as the country OASC coordinator. This municipality has undertaken recent smart cities projects, including:

- Parking availability and online parking ticket payment;
- An open data portal; and
- With the National University of La Plata, an Internet of Things (IoT) initiative focused on streetlight sensors to monitor air quality and pollution, including vehicle emissions and noise.

A sensor project to measure river water levels and prevent flooding is also in development.

As another example, Berisso has focused on urban mobility and transportation, urban security, and disaster prevention. In conjunction with the Inter-American Development Bank, the Ministry of Strategy and Finance of the Republic of South Korea, and the Korean Bank Knowledge Exchange Program, Berisso is also working on city finance and governance innovations.

e-Government initiatives throughout the country have succeeded in bridging public service gaps between rich and poor. During the 2020 COVID-19 global pandemic, for example, telemedicine solutions have allowed information, public health safety, and treatment exchanges that previously had not been possible.

Even where digital infrastructure is minimal, regional governments have provided citizen access to creative e-Government solutions. On such example is Autopista de la Informacion in the Province of San Luis. This digital solution encompasses a web-based network that rings the province with optical fiber, radio and satellite links, a local data center, and specialized apps. In outlying provincial districts, where there are no telephone lines, mobile satellite uplink vans provide internet access for citizens.

2.4.3 Internet of Things (IoT) and Artificial Intelligence (AI)

The Internet of Things (IoT) is the network of physical objects (“Things”) embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. Artificial intelligence (AI) is intelligence demonstrated by machines, mimicking human intelligence. AI is frequently incorporated in IoT devices and systems.

In 2017, the Latin American/Caribbean region hosted 400 million connected devices. By 2023, MIT forecasts that number will reach over one billion connected IoT devices. The region will represent the fastest growth in IoT spending through 2025.

Argentina has begun IoT and AI implementations in both the public and private sectors. In the public sector, smart cities initiatives using one or both technologies include Buenos Aires proper, Tigre City and San Nicolas de los Arroyos (both in the greater Buenos Aires area), as well as several others.

Buenos Aires has undertaken a public-private partnership (PPP) with Phillips Lighting to develop a smart street lighting system using data from multiple municipal departments to optimize streetlight usage and reduce associated power consumption by half. Tigre City has focused on improving citizen safety using IoT cameras to aid local law enforcement in tracking stolen vehicles, reducing vehicle thefts by 80 percent. San Nicolas do los Arroyos has worked with Telefónica to use IoT to manage the municipal vehicle fleet, more efficiently. In real-time, the municipality knows where its connected vehicles are, enabling movement coordination and resulting savings on fuel and maintenance costs.

In early 2020, Nokia signed a contract with Argentine telecom operator Telecom Argentina to allow the operator to offer IoT services to its domestic enterprise customers and across Latin America using Nokia's Worldwide IoT Network Grid (WING). The WING technology will provide Telecom Argentina's customers with opportunities to implement IoT and associated AI solutions in various industry verticals, including automotive, agriculture, utilities, finance, and services.

Oil and gas producer, YPF, has been at the forefront in Argentina for both industrial IoT and AI use. The company has adopted a Digital Agenda reviewed later in this section.

2.4.4 Digital Healthcare and Telemedicine

Digital healthcare is the use of digital technologies in medicine, surgery, dentistry, and health system and office management to enhance the efficiency of healthcare delivery and make service delivery more personalized and precise. Telemedicine is the subset of digital healthcare using ICT technologies to provide clinical health care at a distance, allowing any patient to benefit from access to care and to confer with experts they might otherwise not be able to consult.

Argentina is the second largest healthcare market in the Latin American/Caribbean region. Approximately 50% of residents use public healthcare, which includes both inpatient and outpatient services. Another 45% utilize Obras Sociales, employer/trade union-based insurance plans (or "mutuals"), where the employer/union and the employee each pay a fixed fee. The remaining 5% of patients seek medical care in the private sector. Argentina also hosts a medical tourism industry with particular emphasis on cosmetic surgery.

Healthcare in Argentina is easily accessible in large cities, especially Buenos Aires, but less available in remote and certain other areas. The country hosts in more than 5,000 medical facilities, of which roughly 70% are private and 30% public.

The Ministry of Health and Social Action (MSAS) monitors the three Argentine healthcare sectors: public, social security, and private. The Government Secretary for Health is overseeing the development of a National Telehealth Plan, 2018-2024, highlighting three strategic axes:

1. Strengthening the institutional governance of a new modality of remote health work;
2. Managing the Argentine Telehealth network; and
3. Developing telecare and telemedicine programs.

Formation of a Telehealth Advisory Group, charged with evaluating, reviewing, and discussing key themes of the telehealth agenda is also part of the plan.

The Ministries of Health (MoH) and Federal Planning, Public Investment & Services have been charged with promoting Digital Healthcare, particularly Telemedicine, via the CyberHealth Project. The project focuses on the installation of fiber optic transmission cables, as well as upgrading hospitals to allow for videoconferencing. The CyberHealth project plan includes connecting 325 healthcare institutions for remote consultations and expertise sharing.

Nongovernmental agencies have also supported Digital Health development in Argentina. For example, the World Health Organization (WHO), in partnership with the Pan American Health Organization (PAHO), supported the implementation of an educational telehealth project in the province of Jujuy. The World Telehealth Initiative currently has two women's and children's programs in Northern Argentina: one at Hospital Público Materno Infantil de Salta, a women and children's hospital; the other at Centro Provincial Eva Peron, a pediatric hospital in Santiago del Estero. Both initiatives link to the capabilities of the Garrahan Hospital of Pediatrics in Buenos Aires. Previously, specialty care required flights of two hours or more.

Private companies are participating in Digital Healthcare development in Argentina. Two pilots have focused on reducing cardiac diagnosis and treatment times. U.S.-based GlobalMed is working with Argentine Meditar, one of the largest managed care providers in Latin America, to develop TeleMeditar, a telemedicine system for health care delivery to one million patients across Argentina and neighboring nations. Meditar's areas of medical specialization include:

- Neurosurgery
- Cancer surgery
- Orthopedics
- Traumatology
- Cardiovascular surgery
- Ophthalmological surgery
- Organ transplants
- Assisted reproduction
- Cosmetic surgery and dentistry

Several Argentine venture businesses also are pursuing Digital Health, with offers spanning:

- Audiology apps
- Medical consultation facilitation
- Tele-education
- Imaging analysis
- Social network/medical provider comparison app

- Medical administration via the cloud
- Medical institution management software

Recently, Argentina, with the support of the Federation of Collegiate Medical Entities (CONFEMECO), introduced a project to regulate the use of virtual Digital Health applications to ensure the safety and efficacy of medical treatment in public health institutions, as well as to reduce the possibility of records counterfeiting. The project requires any digital application serving any type of medical care to register with the National Secretariat of Health.

Argentina is well-positioned to grow in Digital Healthcare. The country has a history of successfully working with international and U.S. partners.

2.5 Projects Profiled

Five Argentine ICT projects are profiled following (*Table 2*):

Table 2: ICT Development Projects – Argentina

Project	Sponsor
Plan Conectar 2020-2023 (also includes *Terrestrial Communications Infrastructure: Telephone, Internet and Broadband* and *Data Centers and Cloud Computing*)	Empresa Argentina de Soluciones Satelitales S.A. (ARSAT)
Argentina Open Government Plans and Strategies	Secretariat for Public Innovation
Salta ICT Modernization (also includes *Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband* and *Data Centers and Cloud Computing*)	Salta Municipal Government
YPF Digital Agenda (also includes *Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband* and *Data Centers and Cloud Computing*)	YPF
National Telehealth Plan	Ministry of Health Administration

PLAN CONECTAR 2020-2023	
SUBSECTOR	**Satellites**
LOCATION	**Argentina**
PROJECT VALUE	**$500 Million**

PROJECT SUMMARY

- Plan Conectar 2020-2023 seeks to provide universal access in Argentina to broadband services.
- The plan's primary component is the country's third geostationary communication satellite, ARSAT SG1, scheduled to be launched in 2023.
- ARSAT SG1 will be a high-performance satellite operating in the Ka-band, with a data traffic capacity of more than 50 Gbps. The vehicle will have more than 30 beams covering the entire continental Argentine territory from an altitude of 36,000 km. It will be powered by solar energy rather than by liquid fuel.
- The plan also includes upgrades to three other ICT infrastructures: the national fiber optic network, open digital terrestrial television, and the national data center.

PROJECT BACKGROUND AND DESCRIPTION

ARSAT SG1

ARSAT 1, Argentina's first communication satellite, was launched in 2014. After the launch, in September 2015, of ARSAT 2, the country's second telecommunications satellite, the government approved the Argentine Geostationary Satellite Plan (PSGA) 2015-2035 through Law 27.208. The PGSA is an ambitious 20-year, space-development project including:

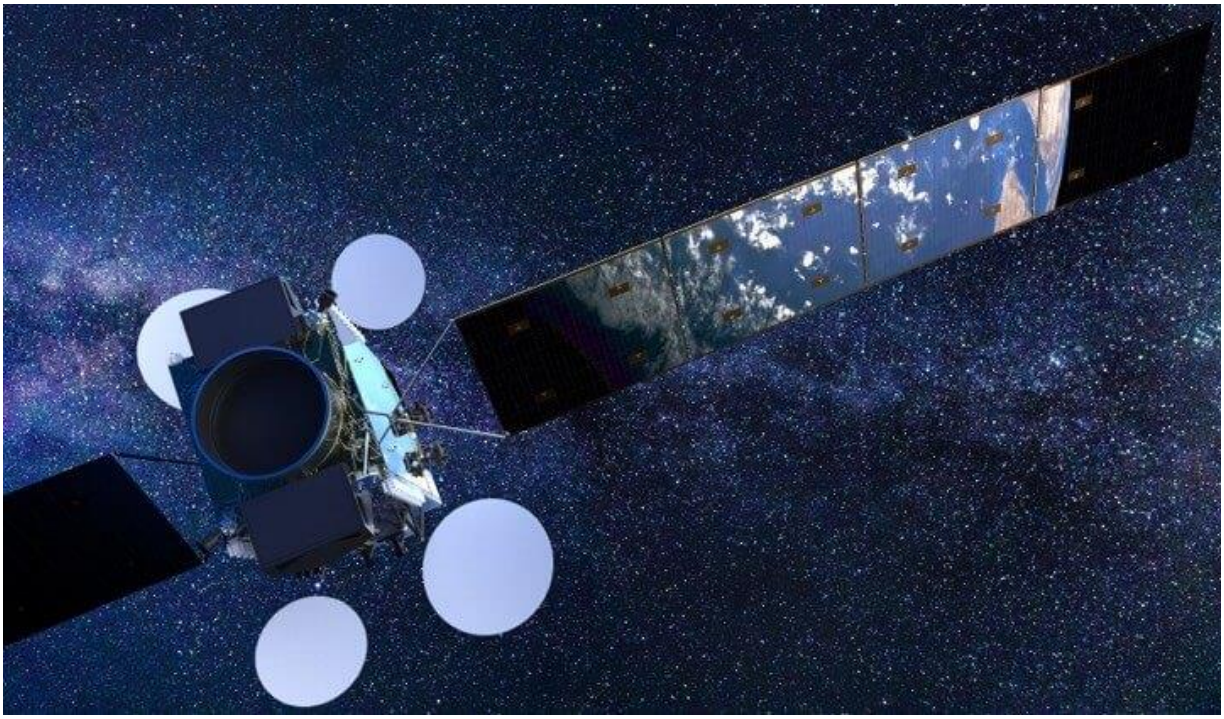
- The launch of eight satellites, including SAOCOM (observational satellites) and ARSAT (telecommunications satellites);
- Development of earth monitoring stations;
- Development of launchers; and
- Management of mobile networks.

Empresa Argentina de Soluciones Satelitales S.A. (ARSAT) was created as a state-owned telecommunications firm in 2006 to manage Argentina's satellite program.

ARSAT SG1, the most significant component of *Plan Conectar 2020-2023* (*Figure 2*), will be a high-performance satellite operating in the Ka-band, with data-traffic capacity of more than 50

Gbps. The new vehicle will have more than 30 beams capable of covering the entire continental Argentine territory and the island of Tierra del Fuego, as well as parts of neighboring countries. All of the ARSAT1, 2, and the future SG1 satellites orbit at an altitude of 36,000 km in the 81° West longitude geostationary slot.

Figure 2: Artist's Rendering of ARSAT SG1



The third ARSAT satellite will not be powered by liquid fuel, as were its predecessors, but rather by solar energy. Half of the mass of the first two satellites was fuel, specifically hydrazine and dinitrogen tetroxide. Upon contact, these fuels spontaneously ignite without the need for oxygen. Most fuel is used in maneuvers to accommodate the satellite into orbit. The rocket launcher only provides an elliptical trip about 300 km above Earth's surface, requiring the satellite itself to reach its orbit of 36,000 km. Once the satellite reaches orbit, it then travels at 11,000 km per hour to maintain its geostationary position. The remaining fuel is consumed periodically to correct the orbit. By switching to solar energy, the vehicle becomes lighter, with more sustainable energy access, allowing a longer lifespan.

ARSAT is working with the Argentine technology development company, INVAP, to design and build the satellite. ARSAT and INVAP built the High Technology Testing Center (Centro de Ensayos de Alta Tecnología or CEATSA) in Rio Negro, allowing satellites to be tested under conditions simulating both launch and in space. INVAP announced a strategic alliance for communication satellites with Turkish Aerospace Industries (TAI) during the G20 summit hosted by Argentina in 2018.

National Fiber Optic Network

ARSAT also manages the national fiber-optic network known as Red Federal de Fibra Óptica (REFEFO, *Figure 3*). Currently, the optical network extends 34,500 km, of which 31,150 km are active and 3,350 km are dark (not yet used).

Figure 3: REFEFO National Fiber Optic Network

The Argentine national network is one of the most extensive in Latin America, connecting over 1,300 localities, primarily those not served by private-sector carriers. REFEFO receives resources from the Universal Service Trust Fund, which provides a fee of one percent of telecommunications companies' billings collected by the telecom regulator Enacom. ARSAT observes that, as a

wholesaler, as it brings connectivity to underserved localities, competition increases, and prices often drop.

The government's connectivity strategy through REFEFO goes hand-in-hand with the policy of the geostationary satellites, according to ARSAT. The company will ensure the available capacity of the new satellite allows the provision of satellite broadband, at affordable prices, to more than 200,000 homes in Argentina. ARSAT will offer the satellite as backhaul in places where the deployment of terrestrial infrastructure is not convenient.

Additional investments in REFEFO contemplated in *Plan Conectar 2020-2023* include:

- Finalize stage 2, lighting up 3,350 km of fiber optic lines not yet in service;
- Equipment upgrades to multiply broadband capacity by a factor of 10; and
- Implement stage 3 by installing an additional 4,408 km of fiber optic lines.

Stage three of REFEFO will connect nearly half a million people to the nation fiber optic network and is expected to have 22 million users by the end of 2023.

Additional "Plan Conectar" Components

Plan Conectar also includes upgrades to the country's system of open digital terrestrial television (DTT):

- New equipment in 100 DTT stations;
- New transmission platform to provide higher resolution; and
- Equipment upgrades to eliminate service interruptions.

With these improvements, 2.5 million households will have access to high-resolution open DTT.

Plan Conectar 2020-2023 also includes an upgrade to the national data center housed at ARSAT's headquarters in Benavidez, Buenos Aires:

- Upgrades to servers, storage, network, and software;
- Migration of public sector applications to the cloud, hosted at this data center; and
- New support infrastructure at the data center for reliability.

Alberto Fernandez, President of the nation, announced *Plan Conectar 2020-2023* at a press briefing on September 16, 2020. Santiago Cafiero, Chief of the Cabinet of Ministers, and Micaela Sanchez Malcolm, Secretary for Public Innovation, also participated in the event.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The launch of the third satellite, ARSAT SG1, is scheduled for 2023. All other components of *Plan Conectar* are also scheduled for completion by 2023.

PROJECT COST AND FINANCING

The overall budget for Plan Conectar is $500 million (37.9 billion pesos), broken out as follows:

Project Tranche	Budget ($ million)
ARSAT SG1 and related ground support	$266
REFEFO upgrades and stage 3	$176
Open DTT upgrades	$6
Upgrades to national data center	$58
Total	***$506***

ARSAT will partially self-finance the plan and use funds from the Secretariat for Public Innovation and the universal services fund (FSU). *Plan Conectar* will seek loans from Corporación Andina de Fomento (CAF), Fondo Financiero para el Desarrollo de los Países de la Cuenca del Plata (Fonplata), and the International Bank for Reconstruction and Development (BIRF).

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies in conjunction with ARSAT SG1 are likely to include:

- Transponder technology and components;
- Antennae subsystem components;
- Solar cell and battery back-up technology and componentry;
- Command, control, and data handling technology and software;
- Guidance and stabilization technology and componentry; and
- Thermal control technology and componentry.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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ARGENTINA OPEN GOVERNMENT PLANS AND STRATEGY	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Argentina**
PROJECT VALUE	**$15-25 Million (Annually)**

PROJECT SUMMARY

- Argentina is implementing its fourth National Open Government Action Plan: 2019 – 2022. Technology enables most programs being implemented under the Plan.
- Open government programs incorporate purchasing and auctioning portals, data platforms, application program interfaces, and GIS tools.
- The Open Government Strategic Plan (2020-2023) and the Federal Open Government Program (2020-2022) will create additional new opportunities but COVID-19 restrictions are delaying several of these opportunities.

PROJECT BACKGROUND AND DESCRIPTION

Argentina is presently implementing its fourth National Open Government Action Plan. The country has been a member of the Open Government Partnership international alliance since 2012. Many of Argentina's successes to date, as well as its future plans, are/will be enabled through technology, especially e-government portals and applications. Symbolically, in May 2020, Argentina successfully held a first virtual congressional session (*Figure 4*) due to the COVID-19 pandemic.

Platforms and applications Argentina has developed and introduced within the context of open government include:

- **COMPR.AR** – the National Public Administration procurement platform. Public entities publish their procurement processes, and suppliers present their offers over the platform in an agile, transparent, and safe manner.
- **CONTRAT.AR** – an electronic management system for public works contracts and concessions. The system also includes information and relevant documentation on procurement procedures, contractor selection, and execution of contracts and public works concessions. CONTRAT.AR replicates the functionality of COMPR.AR with additional features for the size and scope of public works projects.
- **SUBAST.AR** – a transactional platform related to COMPRA.AR to auction off public sector assets no longer required in service.

- **data.gov.ar** – a national public data portal developed by the Directorate for National Data and Pubic Information (DNDIP). This portal contains over 900 data sets and 3,400 folders of information. The portal has served 1.3 million unique users and has responded to over 12 million queries.
- **API Serie de Tiempo** (**Time Series**) – an application program interface facilitating access to thousands of statistical time series published by public entities.
- **GeoRef API** – an application program interface providing standardized geo-referencing addresses for territorial units, including provinces, departments, municipalities, towns, settlements, and streets.
- **Andino.datos.gob.ar (Platform Andino)** – a public data portal to facilitate publication of open data by provincial and local governments. The portal is used by five provincial governments and in more than 50 municipalities, including the City and the Province of Buenos Aires.

Figure 4: Argentine First Virtual Congressional Session – May 2020

Through these efforts and results, Argentina has gained international recognition for open government. Argentina was the first country to have its open and digital government strategies evaluated by OECD criteria and has made substantial progress against these metrics in moving toward becoming an "open state." Until September 2020, Argentina served as co-president of the Open Government Partnership, with South Korea to serve in the upcoming transition.

Argentina is implementing its fourth National Open Government Action Plan. Most of the 15 programs contained in the plan are technology-enabled, including:

- **Transparency in extractive industries** – a thematic portal that publishes economic, legal, and tax aspects of extractive activities (i.e., oil, gas, and mining), as well as cost/benefit assessments. The portal also includes social and environmental information.
- **Visibility of indigenous peoples** - an online geographic information system (GIS) tool accessible via smartphones with updated information on the situation and history of each indigenous community, as well as the policies and programs implemented by the National Institute of Indigenous Affairs.
- **Transparent budget** – an upgrade to the Open Budget website. The existing application answers basic questions:
    - Who spends?
    - How are funds spent?
    - On what are funds spent?

  The update will provide greater transparency:
    - Who is paid?
    - How much?
    - When?

  The application respects the applicable regulations for the protection of personal data.
- **Increasing transparency in the public works contracting system via an upgrade to the CONTAT.AR public works contracting system** - this program will develop a national standard for life-cycle information for public works contracting. A specified group of information and data will be included in an upgrade to the portal.
- **National information system of water and wastewater management** – the initial system with online access (v1.0) will contain at least ten uniform parameters from eight operators in at least eight states, representing over 50 percent of the country's population.
- **Citizen participation in the follow-up of findings from the nation's general *audit*** – a methodology and online platform to follow the implementation of the recommendations of the general audit, as well as broad indices to reflect compliance levels.
- **Active transparency index** – an online dashboard reflecting the level of compliance of all ministries and similar public entities with transparency requirements.
- **Women in the work world** – a thematic portal with information on the labor market in open formats, disaggregated by sex, to make the situation of women visible.
- **Sexuality and rights** – a thematic portal of sexual health and reproductive health policies, disaggregated by province and treatment method.

The other national priority programs in the action plan do not have a technology component.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Implementation of the fourth Open Government Action Plan has been ongoing since 2019. Its original timeline targeted all programs to conclude by August 2021. COVID-19 restrictions have protracted most program implementation areas. In April 2020, the national roundtable decided to postpone the deadline for completing the programs listed in the action plan until August 2022.

The Federal Open Government Program (2020-2022) is being developed as a program under the fourth Action Plan. Initial interviews are complete. Calls to participate in specialized forums were scheduled for March 2020 but have been postponed due to COVID-19 restrictions.

The Argentine government has broad goals for the Plan (2020-2023). Further details are to be developed based on inputs from the COFEFUP and the Federal Open Government Program.

PROJECT COST AND FINANCING

The National Open Government Action Plan does not have a single budget or financing source. The respective ministry, agency, or entity manages each of the 16 individual programs and is responsible for obtaining implementation financing. The annual coordination budget for the Plan has ranged from $3 to 5 million annually over the last two years. Agencies will expend $15 to 25 million annually on the plan.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the various Argentine e-Government initiatives include:

- Hardware
  - Data center componentry (servers, racks, power equipment, HVAC, *et al*)
  - Digital operations center equipment (networking hardware, fiber optic cabling and components, power management hardware, *et al*)
- Software
  - Access to Software as a Service (SaaS) and related scalable programs
  - Custom software/applications
- Advisory services
  - ICT design and development services and consulting
  - Networking design, implementation, and security
  - Application design, development, testing, and implementation
  - Custom programming
  - Civil servant and operator training
  - Legal and policy advisory

CONTACTS

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SALTA ICT MODERNIZATION	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Argentina**
PROJECT VALUE	**$30 million**

PROJECT SUMMARY

- The Salta ICT Modernization Project aims to expand broadband, data center, and related smart city infrastructure.
- The project aims to modernize Salta's ICT infrastructure by expanding its fiber-optic network, upgrading its data management/storage capacities, and introducing smart city infrastructure.
- A feasibility study is available for award to a U.S. company through a USTDA grant to the Salta Municipal Government to define a suitable implementation plan.

PROJECT BACKGROUND AND DESCRIPTION

The City of Salta is the capital of the Argentine province of Salta (*Figure 5*). Salta province is located in the northwestern corner of the country and borders Chile, Bolivia, and Paraguay, in the foothills of the Andes mountains.

The city is the heart of a metropolitan area of population 644,000, which has grown by 20 percent over the last two decades. Hosting more than 535,000 residents, Salta is the sixth-largest city in Argentina. Salta is a popular tourist destination due to its colonial architecture, natural scenery, and climate. Five sectors comprise the city: 1) North (Tres Cerritos area), 2) South (of the Arenales river), 3) East (city entrance and beginning of the hiking path to San Bernardo Hill), 4) West (provincial government headquarters), and 5) Historical (landmark buildings dating to 1582).

Urban growth has brought several issues. As a result, the City of Salta has been working with the province's Modernization Secretariat (created 1.5 years ago) on several focal programs:

- Urban and Environmental Development (PIDUA I and PIDUA II),
- Central Downtown Redesign, the Emissions Reduction Project (RES) to reduce landfill methane gas emissions, and
- Metropolitan Area Development Program (DAMI).

The central concept behind the cooperation is to develop leadership by:

- Encouraging business culture change,

- Redesigning processes,
- Giving back to the community,
- Providing citizens open access to the municipality,
- Connecting the municipality with the world, and
- Enhancing transparency and participation.

Figure 5: Salta, Argentina[7]

To achieve these goals, the Municipal Government of Salta (MGS) seeks to rebuild its infrastructure services and ultimately create a smart city providing connectivity and access to services from any point in the city with competitive speed and high quality of response. Importantly, infrastructure changes required for the project must safeguard the city's cultural heritage and natural environment. ICT development foci include:

1. Upgrading the city's fiber-optic network,
2. Enhancing data management/storage capabilities, including a data center expansion, and
3. Introducing smart city infrastructure.

[7] Brittanica.com, Airways.com, Lobadaesdtepe.com

1. Fiber Optic Network Upgrade

Salta's current fiber-optic network, partially spanning a 60 km^2 metropolitan area, requires physical coverage and reliability upgrades. Salta's objectives for upgrading its Fiber Optic Network include: 1) defining best practices for smart city implementation in cases similar to Salta; and 2) for the existing metropolitan network, developing modifications and expansions required to create a backbone for smart city ICT services in the future, specifically network reliability (fault tolerance), capacity, flexibility, ease of maintenance and avoidance of visual contamination.

The upgraded network will include:

- Single-mode fiber, suitable for air and underground lines
- Support overhead lines of 150 meters
- A minimum of 48 strands
- Devices as required to achieve a multiservice network
- Points of presence for MGS and non-MGS telecom service origination/termination
- City-wide WiFi

2. Enhanced Data Management and Storage Capabilities (Data Center Expansion)

In addition to addressing the near-term outgrowth of current capacity, a Salta Smart City will require orders of magnitude greater computing capabilities. Growth alternatives include:

- Expansion of one of the existing data centers
- Construction of a new municipality-owned data center (Tier III)
- A cloud option in combination with an expansion

The data center, an expected minimum of Tier III, will be an office-grade multi-story building. Lower floors will house application servers, Ethernet switches, and an IP communications network. Upper floors will provide office space for the smart city control center (SCCC).

3. Introducing Smart City Infrastructure

An e-governance system, including citizen-facing applications, will become the interface for the population with MGS. Applications will be made available over different media, including citizen apps, via a portal, and through the municipal website. A Smart City Control Center (SCCC) will support the system.

An ERP system will be the backbone to enable efficient and integrated operations and maintenance of the city. The ERP system will be closely integrated with an e-governance system and become the primary system used for city governance and operations.

Salta's objectives for the introduction of Smart City Infrastructure include the following capabilities:

- Public transportation and urban mobility
- Competitiveness, public sector management, and transparency
- Public safety
- Planning and management of the expansion of the urban areas
- Disaster management and adaptation to climate change (resilience)
- Citizen engagement
- Urban internet access

Citizen access to services will include integrated-platform, multi-services digital kiosks deployed across the Salta. These fixed, dedicated structures will consist of WiFi access points, emergency call buttons, charging points, solar panels, access to citizen services (including bill and payment access) from a touch screen, static advertising, smart card readers, and CCTV. MGS will install kiosks at strategic locations, including public buildings and parks and the Exhibition Pavilion.

MGS also plans to incorporate environmental sensors, an automatic vehicle location (AVL) system, advanced parking management, and building management/access control systems for POP locations in its smart city platform.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

USTDA provided a grant to the Salta Municipal Government to fund a feasibility study for the Salta ICT Modernization Project. The feasibility study's objective is to support the expansion of broadband, data center, and related smart city infrastructure in the City of Salta. Following the feasibility study, a FEED/design study is likely. Project implementation will begin shortly after that.

PROJECT COST AND FINANCING

MGS projects the Salta ICT Modernization project will require a total investment of approximately $30.1 million (*Table 3)*. Upon completion of the USTDA-sponsored feasibility study, MGS expects to present the project to various national and international cooperation agencies for funding.

Domestically, the Salta initiative is in line with REFEFO, an Argentine federal government program deployed throughout the country to close the economic development and opportunities gap between large urban centers and smaller towns. Further, Salta Province is part of the Belgrano Plan, a social, economic development and infrastructure program the Argentine federal government set in motion to pay back what is considered a historical debt to the ten Northern provinces and their populations. An additional possible domestic funding source is the Federal Ministry of Science, Technology, and Innovation (and associated agencies), offering a wide range

of financing instruments to support innovative technology projects, infrastructure modernization, and other technology-related support.

Table 3: Estimated Salta Fiber Optic Network, Data Center Upgrade and Smart City Equipment Project Costs[8]

Project Element	Total Cost ($ Million)
1. Fiber Optic Network	5.7
2. Data Center Upgrade	15.3
3. Smart City Equipment	9.1
TOTAL	**30.1**

Several funding opportunities also exist with multilateral financing organizations:

- The IDB's ESC is a technical assistance program supporting central and local governments in developing and implementing urban sustainability plans. The City of Salta has been a part of this program since 2012.
- The Development Bank of Latin America (CAF) offers support in several areas related to this project, including the digital transformation of the state, telecommunications and ICT, and urban mobility.
- The World Bank is the multilateral financial organization already working with Argentina on modernization and innovation projects to improve public services.

A final project financing option is to structure the project, in whole or in part, under a public-private partnership**.** In principle, MGS would obtain financing to pay for the project deployment, reducing private party risk. The private parties would be responsible for the maintenance, upkeep, and possibly operations of selected components of the project.

U.S. EXPORT OPPORTUNITIES

U.S. companies providing technologies, goods, and services relevant to the Salta ICT Modernization already enjoy a substantive market share in Argentina. For example, the current MGS data center uses technology developed by IBM, Dell, and HP.

Investment opportunities in conjunction with Salta ICT Modernization project include:

Fiber Optic Network

- Optical fiber
- Fiber-optic cabling hardware
- Fiber-optic, network-management hardware and software
- Network modeling, design, and engineering services

[8] USTDA RFP: Feasibility Study for the Salta ICT Modernization Project in Argentina

Data Center

- Operations hardware and software including servers, racks,
- Site operations/security systems and services including power, power back-up, and HVAC
- Cybersecurity software, services, and training
- Data center design, planning, and engineering services
- Network operations services and training
- Cloud services

Smart Cities

- Sensors including geospatial, traffic/transportation/parking, security, and weather
- Cameras and video content analytics
- Traffic and signal systems and software
- Supporting IT equipment and software including geospatial, emergency, health crisis, and disaster management applications

CONTACTS

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YPF DIGITAL AGENDA	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Argentina**
PROJECT VALUE	**$50 Million (Annual Budget as Part of CapEx)**

PROJECT SUMMARY

- YPF adopted a seven-year Digital Agenda in 2018 covering all the energy/oil and gas company's business areas – upstream, midstream, and downstream.
- The YPF Digital Agenda envisions deployment of a wide range of technologies and solutions, including remote operation and control of oil wells and fields, high-performance cloud computing for fracking simulations, artificial intelligence for improved decision making, virtual and augmented reality for training and safety management, the selective introduction of IoT, and management of the YPF internal telecommunications network.

PROJECT BACKGROUND AND DESCRIPTION

YPF is a vertically integrated oil and gas company. The company was 51 percent renationalized in 2012. Argentina produced approximately 500,000 barrels of oil daily in 2019, for which YPF was responsible for nearly half.

YPF created an executive management unit of Technology and Innovation in 2017. In 2018, the company adopted a seven-year Digital Agenda covering all business areas – upstream, midstream, and downstream – and including a broad spectrum of ICT technologies and solutions.

In 2015, YPF focused its upstream developments on the unconventional (large deposits of shale oil and gas) Vaca Muerta formation. In 2019, investments in the Vaca Muerta deposit were $1.5 billion out of YPF's total investment budget of $3.5 billion. Technology is playing a key role in the development of this field.

Vaca Muerta, in the province of Neuquén, is located more than a thousand km from Buenos Aires. Being an inhospitable area, the wells in the unconventional fields are tele-supervised, with data transmitted to a central control room. YPF invested in telecommunication infrastructure to the point of becoming one of the largest telecom operators in Argentina. The company's network spans 82,000 km^2. YPF Tecnología (Y-TEC), the company's research and development division, developed artificial intelligence algorithms to model and simulate the Vaca Muerta subsoil. These models predict and optimize how rock will be fractured and how it will react to certain stimuli. The model results form the basis of the fracking plans, which are then revised in the field. Due to

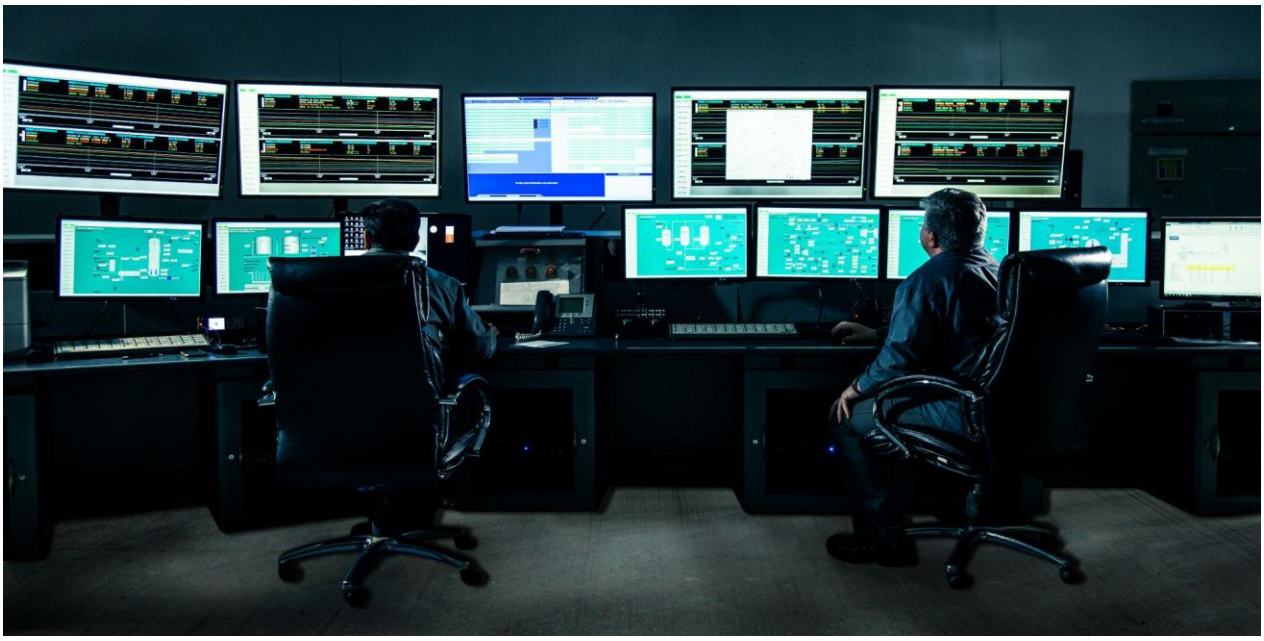
the computational requirements of these algorithms, YPF runs them via high-performance cloud computing.

The YPF Digital Agenda calls for migrating the company's entire application footprint to the cloud. Latency issues protract this migration, as existing data centers in Argentina do not offer the high-performance standards the company requires for many of its real-time applications. Hence, initial migrations focus on those able to tolerate higher latencies, such as the Vaca Muerta modeling and simulation.

Development costs at Vaca Muerta have declined from $32/barrel to $9/barrel since 2016. Standardized business processes, labor flexibility, and technology have been the three key factors contributing to this productivity improvement. The adoption of new technologies under the Digital Agenda will be the most significant factor in continuing to achieve productivity enhancements in these fields.

To date, the YPF Digital Agenda has emphasized digital control rooms (*Figure 6*), allowing a large number of assets to be monitored with a small group of connected personnel. YPF has implemented collaborative environments where different remote monitoring rooms interact – allowing exploration personnel to work directly with production and logistics staff.

Figure 6: YPF Digital Control Room



In the logistics function, ground transportation is monitored in real-time, including trucks serving the upstream area and those leaving refineries to supply gas stations. YPF is developing analytic capabilities for logistics, trying to optimize the positions of various vehicles and the associated decision-making processes. Informed decision making is key to respond to unforeseen events.

YPF is developing applications using augmented reality throughout the value chain. Upstream, well inspection is enhanced by adding a layer of augmented reality to facilitate remote assessment. Downstream, the company has developed augmented reality applications to optimize maintenance tasks and procedures. Implementation of the YPF Digital Agenda will see a considerable increase in the company's use of augmented reality applications.

Virtual reality also will have a significant role in YPF's Digital Agenda. The company's initial virtual reality applications are simulators used for training purposes. The first virtual reality application simulates the process of loading and unloading tanks. This activity, if not executed properly, may result in spills. Involved in this process are both employees and contractors (e.g., carriers), resulting in a degree of personnel rotation that increases the need for adequate training. YPF's initial virtual reality application is proving to be effective both for training and monitoring the associated process and results. YPF plans further virtual reality applications as its Digital Agenda continues.

Artificial intelligence (AI) also plays a key role in YPF's Digital Agenda. AI tools of interest include machine learning, advanced analytics, and video analytics. Examples of existing YPF AI applications include:

- Algorithms to correct and optimize dynamometers for well start-up where both vertical and horizontal segments are present
- Facial recognition for access control in YPF's central office
- Video analytics to detect unsafe work practices in the process area

YPF has developed an AI application to address the problem of paraffination in shale oil wells. Paraffination is a slow deposition process where fatty substances can eventually block a well, requiring expensive recuperation techniques. YPF has developed an inference algorithm predicting the formation of paraffin, by analyzing processes the human eye is unable to detect, based on pressure measurements at the mouth of the well. Given highly favorable cost-benefit ratios, YPF is earmarking AI for several new applications in future phases of the digital agenda.

To date, YPF's experience with big data has been limited to the petabytes of information available from its retail business, which carry out over 1 million transactions daily at over 1,500 pumps throughout its network of service stations. The next phases of the Digital Agenda will focus on expanding the data architecture and strategy of data governance to create data lakes, data warehouses, and extraction tools following world-class standards.

The Internet of Things is under evaluation for the future phases of the digital agenda. For now, YPF is observing more favorable cost-benefit ratios for AI applications than it expects from IoT.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

YPF adopted its seven-year Digital Agenda in 2018. The company is in its third year of implementation. To support its Digital Agenda, YPF has established a Center of Excellence (COE) in advanced analytics within Y-TEC. The COE is dedicated to executing AI and data science

projects across all YPF businesses. In a single department, the COE combines data scientists, process modeling experts, and IT professionals to provide integrated oil & gas solutions. The COE delivered its first solutions in 2019 and currently manages a high-potential portfolio of more than 20 projects under execution.

PROJECT COST AND FINANCING

YPF's Digital Agenda affects all areas of the company – upstream, midstream, and downstream, as well as central management and the R&D arm, Y-TEC. The Digital Agenda does not have a budget per se but is integrated into each business unit's capital expenditures.

YPF's total capital expenditure in 2019 was $3.5 billion. Before the COVID-19 shutdown, YPF announced a capital budget for 2020 of $2.8 billion, owing to fewer exploratory and pilot projects during the year and much lower gas production. In November 2020, YPF estimated 2020 CAPEX to be approximately $1.5 billion.

YPF does not disclose the allocations of portions of its capital expenditures, nor does it indicate its ICT expenditures explicitly. Typically, ICT expenditures for integrated oil and gas companies are on the order of five percent of CAPEX, including legacy corporate and operational systems as well as networks, plus state-of-the-art technologies included in digital transformation such as IoT and AI. On that basis, YPF's estimated budget for implementation is 0.5% of CAPEX or approximately $15 million annually.

U.S. EXPORT OPPORTUNITIES

U.S. technology company capabilities align well with likely YPF needs under its Digital Agenda. Export opportunities will include:

- Artificial Intelligence (AI)
  - Oil- and gas-specific application and AI tool and software development
  - Technical and business advisory services
- Cloud Computing
  - High-capacity remote location-to-data center technologies
  - Edge computing and cloud center access
  - Technical advisory services
- Internet of Things (IoT)
  - Upstream remote and preventative maintenance support
  - Midstream environmental management and compliance reporting
  - Downstream real-time supply chain and inventory management

CONTACTS

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NATIONAL TELEHEALTH PLAN	
SUBSECTOR	**Digital Healthcare and Telemedicine**
LOCATION	**Argentina**
PROJECT VALUE	**$25 Million+ (Annually)**

PROJECT SUMMARY

- The National Telehealth Plan will support universal health coverage using ICT solutions, under standards of connectivity, security, and privacy of information.
- Under the plan, patients and professionals will be able to access consultations, distance education, resources, and care, overcoming geographic barriers and problems derived from the unequal distribution of health resources.

PROJECT BACKGROUND AND DESCRIPTION

The Ministry of Health Administration approved the National Strategy for Digital Health 2018-2024 in 2018. This strategy reinforces the Argentine commitment to universal health coverage and access to quality health services through interconnected information systems and health care applications.

The National Telehealth Plan is a specific line of action within the broader strategy to enhance remote patient care and second medical opinions. The plan addresses standards and procedures to create an interconnected network, at the national level, to facilitate the use of information and communications technologies (ICT).

The telehealth plan emphasizes four specific functions (*Figure 7*):

1. **Telemedicine** - remote communication between patient and the health team facilitated by technology.
2. **Teleconsultations** - communication between two or more members of the health team (often between doctors, primary care and other specialists), without the presence of the patient.
3. **Tele-management** - activities carried out to lead, organize, or build models and strategies between institutions, health teams, and the community through ICT solutions.
4. **Tele-education** - use of ICT to provide distance education to health teams and/or the community.

Figure 7: Telehealth in Argentina[9]

The benefits expected from the implementation of the telehealth plan include:

- Promoting improvement in care by bringing specialties together not usually consulted during the first level of diagnosis and treatment;
- Reducing inequality gaps concerning the distribution of certain specialties across the nation;
- Reducing waiting times (both in diagnosis and treatment) for access to health teams;
- Reducing the number of referrals within the health system;
- Improving information flows for referrals; and
- Collaborating in the formation and training of health teams.

The telehealth network incorporates a series of telehealth nodes. Each node corresponds to a unique physical space, such as a medical office or a training classroom. A specific team is associated with each node, including health care providers, administrative personnel, and technology support staff. Each node also has its own technology infrastructure.

The national plan classifies nodes into five categories:

- **Category 1** - asynchronous telehealth, ideally integrated into electronic medical records or as a stand-alone application. Category 1 allows asynchronous teleconsultations to other nodes following defined network standards.
- **Category 2** - synchronous telehealth, with videoconference equipment or web conference application. Category 2 allows tele-education and teleconsultations in real-time.
- **Category 3** - asynchronous query resolution services for teleconsultations supported with a query management application. Usually, this service is in a hospital and staffed with medical specialists.
- **Category 4** - synchronous query resolution services or tele-education. Category 4 consists of professionals and health teams available for video conferencing with other professionals,

[9] Cisco

using a shift labor system and the same technology as Category 2. Queries are made by appointment, specifying time and duration.

- **Category 5** - the highest performing category possible in terms of Telehealth. Category 5 supports telemedicine, tele-education, tele-management programs, and tele-research. It also interfaces with the National Directorate of Health Information Systems records for monitoring and evaluation of activities.

Currently, the Telehealth network consists of more than 500 nodes across the country (*Figure 8*), including: areas of the Government Secretary of Health; provincial ministries of health; hospitals of different levels of complexity; centers of primary care; institutes; and universities.

Figure 8: Existing Argentine Telehealth Nodes

Critical actions for implementing the plan at the national level include:

- **Legal and regulatory framework** - a committee of experts will draft proposed legislation and regulations to support the telehealth system. A primary concern is access to patient information for health care while maintaining strict information privacy.
- **Technical standards** - specifications for the five categories of nodes and their communication protocols.
- **Functional designs** - specifications and requirements for standard applications able to be shared among clinics and hospitals.

- **Centralized infrastructure** - hardware, systems, and solutions to monitor and evaluate the telehealth plan and its implementation.

Most of the efforts and investments required to implement the Telehealth Plan will occur at the jurisdictional or provincial level. These efforts include provincial diagnoses and inventory of existing facilities/ICT capabilities, as well as provincial telehealth implementation plans.

The provincial implementation plans consider legal, regulatory, information security and privacy, technological, and infrastructure aspects. They also address the organizational and cultural implications of telehealth practices for institutions and health care professionals. The plans conclude with a budget, financing plan, and phased roll-out plan. The technical team at the Ministry of Health Administration supports the provincial telehealth diagnoses and planning.

A vital element of the roll-out plan is replicable and scalable projects at the provincial level. Provinces can share their experiences with others so that all scalable projects benefit from lessons learned from others.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The National Telehealth Plan was adopted by Resolution 21/2019 on January 8, 2019. Its targeted timeframe runs through 2024.

At the national level, the advisory committee has met and provided initial recommendations. During 2019, the Ministry of Health Administration organized two workshops to support the provincial diagnoses and implementation plans.

The 24 provinces are carrying out diagnoses and preparing implementation plans at varying speeds. Some provinces are piloting replicable implementation projects as well. Four have already presented their telehealth implementation plans.

The technical team to support the Telehealth Plan at the Ministry of Health Administration has diverted resources from the plan temporarily to support a new application, tele-COVID. Tele-COVID serves to track suspected or confirmed cases of COVID-19 to prevent the movement of infected people. Tele-COVID also allows for continuity of healthcare for groups at risk. These include patients with chronic diseases, pregnant women, newborns, and young children, people with disabilities, and those who require psychological support.

PROJECT COST AND FINANCING

The National Telehealth Plan does not have a single budget or financing source. Each of the 24 provincial telehealth implementation plans will include a budget and a financing plan. The annual coordination budget for the plan is $2.5 million in 2020. Overall plan implementation costs are estimated to exceed $25 million annually across the 24 provinces.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the Argentine National Telehealth Plan will vary depending on the level and capabilities of existing telehealth infrastructure across the various Argentine provinces. Provinces with newer and more sophisticated telehealth systems will likely require more in the way of services and occasional, targeted software/app development. For provinces with antiquated or missing infrastructure, hardware, software and services will be required. The following are areas of anticipated opportunity for U.S. company exports:

- Hardware
  - Data center componentry (servers, racks, power, HVAC, site security, et al)
  - Digital operations center equipment (networking hardware, fiber optic cabling and components, power management hardware, et al)
  - Medically-specific ICT capital equipment and devices for patient diagnosis, treatment, and monitoring
- Software
  - Access to Software as a Service (SaaS) and related scalable programs
  - Custom software/applications – patient charting and tracking, patient, record keeping, medical and administrative software tools
  - Cybersecurity including patient data security
- Advisory services
  - Telehealth design and development services and consulting
  - Networking design, implementation, and security
  - Application design, development, testing, and implementation

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3 BRAZIL

3.1 ICT Demographics

Brazil has a landmass of approximately 8.5 million square km, just slightly smaller than the United States. Its coastline extends about 7,500 km along the Atlantic Ocean, making it a desirable location for landing numerous high-capacity, undersea, fiber-optic telecommunications cables. The country borders all other South American countries except Ecuador and Chile. Most of the Pantanal, the world's largest tropical wetland, covers the country's west-central portion. Both landscape and weather patterns are considerations for siting ICT infrastructure and for their maintenance in some areas of Brazil.

A large majority of Brazil's 212 million people reside along the Atlantic coast or relatively nearby inland. Over 87 percent of Brazil's population is urban, primarily residing in the southeast among the country's three largest cities, São Paulo, Brasilia, and Rio de Janeiro. With its sizeable base of ICT consumers, Brazil is the only South American nation in which Portuguese is the official and most widely spoken language.

3.2 ICT Sector Development

As measured by telephone, internet, and fixed broadband access, Brazil's existing ICT sector meets or exceeds world levels, except per capita mobile telephone usage. Brazilians are already extensive social media consumers, and the country is a pioneer in m-commerce (commerce via mobile phone). Brazil is fifth and sixth in the world, respectively, in terms of total fixed broadband and mobile cellular subscriptions, though 74th and 90th on a population-adjusted basis[10].

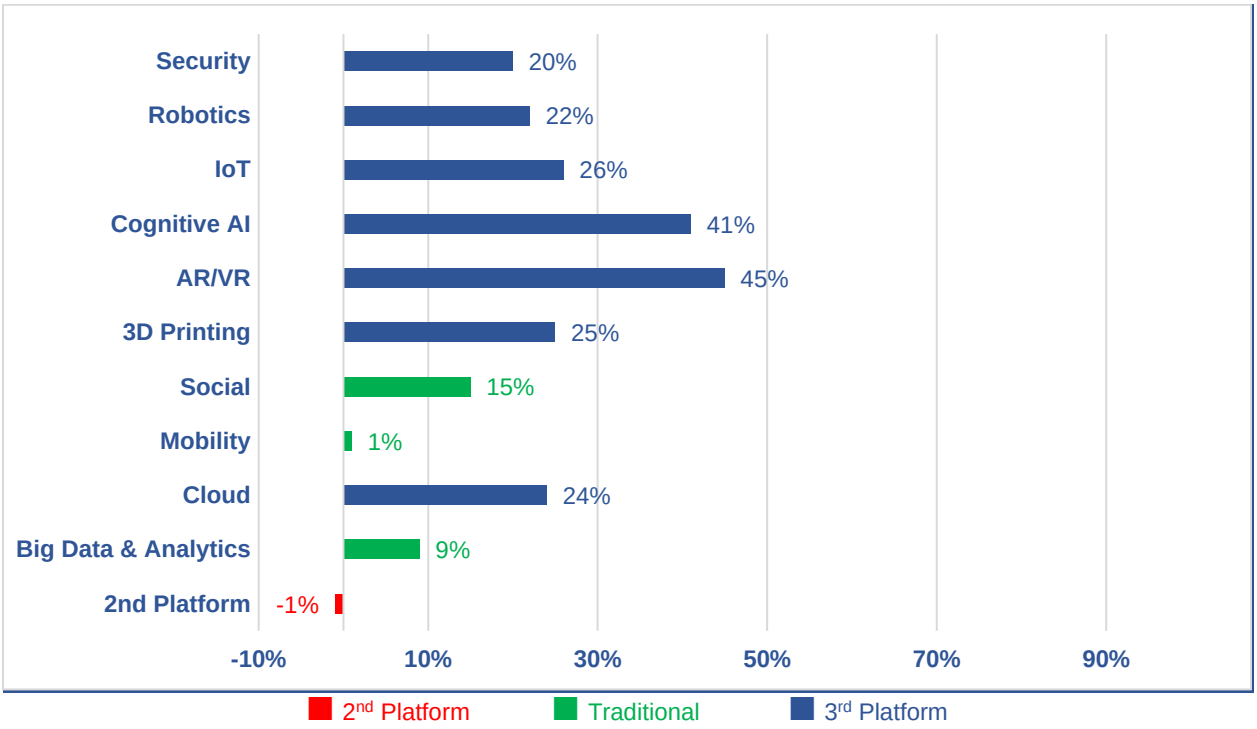
In 2019, the Brazil ICT market in total was about three percent of the global aggregate, or in the range of $150 billion[11], with an estimated compound average annual growth rate (CAGR) of six percent through 2023.[12] The global COVID-19 pandemic has had a dampening effect for 2020 investments and growth. Recent growth has been driven mainly by internet (including premium content) and information technology (IT) services. Future growth rates for newer ICT technologies (third platform) will be considerably higher than for more traditional ICT goods and services (*Figure 9*). Today, Brazil produces relatively few ICT goods, but its services sector is reasonably well developed.

In 2015 and 2016, Brazil faced the worst recession in its history, slowing economic growth. Between 2016 and 2018, the economy began to recover. Since 2018, the current government has featured infrastructure projects and reduced foreign investment barriers. The 2020 COVID-19

[10] International Telecommunications Union
[11] Brasscom, SelectUSA.gov, Frost & Sullivan, Brazilian Software Association
[12] Euromonitor

global pandemic has dampened the global economy, including in Brazil, though demand for broadband has increased in the country by 50% as a result of the public health emergency.

Figure 9: ICT Sector Projected Growth, 2019-2020 - Brazil[13]



The Brazilian government has undertaken Brazil ICT 2022, a plan to define a strategy and action plan for the country's various ICT sectors. Participating are BrassCom and the Brazil Association of Information and Communications Technology Companies, including American ICT member companies Cisco, IBM, Microsoft, and Oracle. McKinsey and Company advise the effort. The initiative's 2022 completion target coincides with the next Brazilian presidential election and the country's bicentennial.

Most leading global ICT technology companies have offices or operations in Brazil. Both public and private enterprise initiatives have allowed Brazil to emerge as a global and regional ICT leader. In 2019, total venture capital investment in Brazil, much of it directed to ICT, reached nearly $2.5 billion, from a level of less than $280 million in 2016.

Numerous government initiatives at the country-, state-, and city-levels are focused on extending Brazil's digitization. For example, the National Telecommunications R&D center is establishing a 5G reference center, while the state of Rio Grande do Sul is sponsoring a program of cloud deployment and contracting. The city of São Paulo is working with both state and federal agencies to establish an Innovation Cluster.

[13] IDC

The United Nations International Telecommunication Union (UN-ITU), the UN's specialized agency for information and communications technologies, has sponsored three projects in Brazil:

- A "next generations" telecommunications project completed in 2009,
- An ongoing project (2019-2022) to support Brazil in creating a regulatory environment conducive to digital transformation, and
- An ongoing project (2000-2022) to support the implementation of the National Telecommunications Agency (ANATEL) in Brazil.

3.3 Regulatory Landscape

Agência Nacional de Telecomunicações (ANATEL) is the principal telecommunications regulator in Brazil, created in 1997 by the General Telecommunications Act. ANATEL is administratively and financially independent and not subordinate to any other government agency, despite its historical relationship to the former Ministry of Communications, which was subsumed in 2016 under the Ministry of Science, Technology, and Innovation (MITIC).

Until 1997, the Brazilian telecommunications sector comprised state companies under the jurisdiction of Telebras. Telebras was broken up into twelve companies and auctioned to private bidders in 1998. The former long-distance portion of Telebras became Embratel, acquired initially by MCI (U.S.), but during MCI's bankruptcy, was acquired by América Móvil, the Mexican telecommunications giant, who operates it today.

ANATEL's primary responsibility is to ensure appropriate development and expansion of Brazil's telecommunications sector, supplying user demand and guiding fair play among competitors. Its specific regulatory duties include:

- Ensuring the population has access to telecom services at affordable prices and acceptable quality.
- Encouraging the expansion of telecommunication networks and services.
- Enforcing competition between providers and ensuring service diversity in partnership with Brazil's Council for Economic Defense (CADE).
- Setting quality standards compatible with user demand.
- Promoting investment opportunities and industrial and technological development.
- Implementing, within the agency's scope, Brazilian policies for telecommunications.
- Representing Brazil among other international telecom organizations.
- Managing the available frequency spectrum and satellite orbit usage for telecommunications, including creating applicable regulations.
- Publishing and authorizing product homologation, according to established standards and regulations.
- Managing conflicts of interest between telecommunication services providers.
- Addressing any infractions to user rights.
- Acting in the control, prevention, and cessation of infractions of economic order, including the defense of competition.

MITIC is also actively involved in the Brazilian ICT sector. It coordinates science, technology, and innovation activities across Brazil and sponsors many ICT-related projects.

There are more than 100 TV and 1,000 radio stations in total, most privately owned, though highly concentrated.

3.4 ICT Sectors Profiled

Brazil is a large and growing ICT market with visibility on the world stage. Investment opportunities span all ICT sectors, with high growth opportunities expected in newer technology segments, such as subsea, satellite, IoT and AI, fitting many American companies' expertise. This Resource Guide reviews Brazilian ICT development projects spanning four ICT subsectors:

- Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband
- Subsea Communications Infrastructure
- Smart Cities and e-Government
- Internet of Things (IoT) and Artificial Intelligence (AI)

3.4.1 Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband

The vast majority of ICT network infrastructure resides on land. Nonetheless, key transmission infrastructure also exists in space (see *Satellites*) and on the ocean floor (see *Subsea Communications Infrastructure*). Communications networks may be wired, wireless, or a combination of the two and may be as simple as the connection of devices within a home or as complex as serving millions of subscribers throughout a country or across the globe. Although modern technology has blurred the lines in terms of ICT networks and service crossovers, three key areas represent the majority of global communications today:

- Telephony
- Broadband
- Internet

Brazil hosts a sophisticated terrestrial communications network infrastructure overall, although coverage across the country varies appreciably. Coverage and technology are at world-class levels in sections of major Atlantic, southern coastal cities. At the same time, service is less secure in population-sparse regions and some urban areas.

Mobile telephony has enjoyed generally strong growth in Brazil. The 2020 COVID-19 global pandemic, though, has weakened revenues and growth due to consumer caution/lack of income, closure of retail outlets for phone purchases, and unavailability of imported handsets and related components. The largest mobile telephony providers include Vivo (Telefônica/Portugal Telecom), Claro (América Movil), TIM (Telecom Italia Mobile), and Oi (Telemar). Implementation of 5G

technology, including a spectrum auction, was planned for 2020 but has been temporarily delayed due to the pandemic.

The largest internet service providers (ISPs) in Brazil include Vivo, Claro, Oi, Algar, and TIM. Because of the large landmass of Brazil, numerous regional ISPs also operate. Nearly 50 percent of internet connections in the country exceed 34Mbps. Even in smaller cities, high-speed internet access already serves 21 to 37 percent of users.[14]

Despite overall penetration being only slightly above regional averages, the country hosts one of the largest broadband markets in Latin America. Oi (DSL) is the Brazilian broadband leader, followed by Net (mostly cable) and Vivo (FTTH and DSL). In August 2020, mobile and fixed broadband speeds in Brazil averaged 28.48 and 63.73 for download, 10.18 and 37.12 Mbps for upload, and 43 and 14 milliseconds for latency, respectively, positioning Brazil at 69th in the world.[15]

3.4.2 Subsea Communications Infrastructure

Brazil serves as a regional hub for international subsea fiber optic cable landings, as well as supporting domestic-service subsea cables. The country's principal international cable landing stations are at Fortaleza, Rio de Janeiro, Santos (São Paulo), and Praia Grande, with two international cable linkages established at the Salvador landing station, as well. The country hosts eleven high capacity, internationally connected subsea fiber optic cables, with another two in development (*Table 4*).

Brazil also supports subsea fiber optic cable systems to service domestic needs. Google's cable, Junior, Ready for Service (RFS) third-quarter 2018, runs 390 km between Rio de Janeiro and Santos. The longest domestic line is the Festoon. The Festoon, an Embratel cable, was RFS in 1996 and runs 2,543 km along Brazil's Atlantic coast. It connects not only the international landing stations but also the following landing points for the domestic Brazilian market:

- Atafona;
- Macaé;
- Vitória;
- São Mateus;
- Porto Seguro;
- Ilheus;
- Sitio;
- Aracajú;
- Maceió;
- Recife;
- João Passoa; and
- Natal.

[14] Latin America Business Stories
[15] Speedtest.net

Table 4: International Subsea Fiber Optic Cables Landing in Brazil[16]

Cable	Operator	Length (km)	Landing Point(s)	Distant Landing	RFS Date
EllaLink	EllaLink Group	6,200	Praia Grande & Fortaleza	Sines, Portugal	2021 (under construction)
Malbec	GlobeNet/ Facebook	2,500	Praia Grande & Rio de Janeiro	Las Toninas, Argentina	Q3 2020 (under construction)
Seabras-1	Seaborn Networks	10,800	Praia Grande	Wall Township, NJ, USA	9/2017
América Móvil AMX-1	América Móvil	17,800	Rio de Janeiro, Salvador & Fortaleza	Baranquilla, Colombia San Juan, Puerto Rico	2014
BRUSA	Telxius	11,000	Rio de Janeiro & Fortaleza	Virginia Beach, VA, USA	8/2018
GlobeNet	GlobeNet	23,500	Rio de Janeiro & Fortaleza	Barranquilla, Colombia and Tuckerton, NJ, USA	10/2000
SAm-1	Telxius	25,000	Rio de Janeiro, Santos & Fortaleza	Valparaiso, Chile	3/2001
SAC	Telecom Italia Sparkle, CenturyLink	20,000	Rio de Janeiro & Fortaleza	Valparaiso, Chile	9/2000
Americas – II	Embratel and 11 others	8,373	Fortaleza	Camuri, Venezuela, Willemstead, Curaçao	8/2000
Atlantis – 2	Embratel and 15 others	8,500	Fortaleza	Carcavelos, Portugal, Praia, Cape Verde	2/2000
Monet	Angola Cables, Algar Telecom, Google and Antel Uruguay (Tannat cable)	10,556	Fortaleza & Santos	Boca Raton, FL, USA	12/2017
SACS	Angola Cables	6,165	Fortaleza	Sangano, Angola	9/2018
SAIL	Camtel, China Unicorn	5,800	Fortaleza	Kribi, Cameroon	9/2018

International cable projects in development include the EllaLink cable to Portugal and a cable between Brazil and Argentina. The GlobeNet/Facebook Malbec cable will link São Paulo and Rio de Janeiro to Buenos Aires, with a branching unit reaching Port Alegre, Brazil. It will use recent

[16] SubmarineCableMap.com, Seaborn Networks

enhancements to fiber optic technology, including Spatial Division Multiplexing (SDM), to deliver double the current capacity to Argentina and provide a high-capacity pathway between Argentina and the United States.

The Tannat regional cable, co-owned by Google and Uruguay's state-run telephone company, Antel, originally linked Maldonado (near Montevideo) to Brazil at Praia Grande/Santos in the state of Sao Paulo, and onward to the Monet cable. During 2020, Tannat was extended to Argentina, with Argentine regulator, Enacom, authorizing the extension in July and Enacom, Antel and Google announcing completed installation in December.

Domestic projects include an extension of the Seabras-1 cable to Recife to service the state of Pernambuco, as well as surrounding states in northeastern Brazil.

3.4.3 Smart Cities and e-Government

In 2018, São Paulo, Curitiba, Rio de Janeiro, Belo Horizonte, and Vitoria ranked as the top five Brazilian smart cities based on 11 development indicators.[17]

São Paulo has focused on using digital tools and technology to reduce city bureaucracy. Its Descomplica (Uncomplicate) program, which includes Descomplica Digital, a specialized training, and electronic application and services portal, offers more than 350 digitized municipal services. The city also hosts a large and vibrant innovation/entrepreneurship cluster, attracting a high proportion of Brazilian invested capital, as well as tech giants, including Amazon, Google, Netflix, and Spotify. A challenge to full smart cities implementation in São Paulo is the diversity of its urban landscape, making uniform service delivery challenging. As a result, lists of top global smart cities frequently omit São Paulo, despite its overall strong digital infrastructure.

In 2017, Curitiba began a smart city initiative, "Vale do Pinhão," to accelerate smart city development projects. Vale do Pinhão includes several pillars to better integrate the municipal government with key stakeholders, including universities, not-for-profit organizations, companies, and citizens. Upcoming projects span smart street lighting, initiatives to improve transportation capacity management, and a city innovation hub. Also, Curitiba plans to develop a "Digital Wall" to increase municipal security using a fiber-optic network and a new monitoring center.

Building upon efforts initiated for the 2014 FIFA World Cup and the 2016 Olympics, Rio de Janeiro has made strides in adopting smart-city technologies. Early projects focused on safety and security for citizen and visitor safety, early warnings for weather-related disaster prevention, and freedom of information. More recent projects have included enhanced mobility, modernization of traffic infrastructure (Digital Traffic), and air quality enhancement. By 2019, Rio de Janeiro ranked as 48th of the 50 top Smart City Governments[18] globally, the only Latin America Caribbean region city included. Selection criteria included:

[17] Connected Smart Cities.com.br
[18] Eden Strategy Institute and ONG&ONG

- Vision;
- Leadership;
- Budget;
- Financial incentives;
- Support Programs;
- Talent-readiness;
- People-centricity;
- Innovation ecosystems;
- Smart policies; and
- Track record.

Belo Horizonte programs to date have focused on enhancing mass transportation and addressing the loss of life from natural disasters such as flooding and landslides. The city also hosts several hundred startups as a result of its innovation efforts. Vitoria's focus has spanned health, education, e-governance, and promoting innovation and entrepreneurship among its population.

Thirteen Brazilian cities are members of the Open & Agile Smart Cities (OASC) network:

- Anápolis (Goiás);
- Colinas do Tocantins (Tocantins);
- Cuiabá (Mato Grosso);
- Garanhuns (Pernambuco);
- Nova Friburgo (Rio de Janeiro);
- Olinda (Pernambuco);
- Parnamirim (Rio Grande do Norte);
- Porto Alegre (Rio Grande do Sul);
- Recife (Pernambuco);
- Rio das Ostras (Rio de Janeiro);
- Taquaritinga (São Paulo);
- Uberlândia (Minas Gerais); and
- Vitória (Espírito Santo).

3.4.4 Internet of Things and Artificial Intelligence

In October 2017, Brazil adopted a National IoT Plan. This plan was predicated on the success of the 2010 Brazil National Broadband plan that was instrumental in the rapid adoption of broadband technologies and capabilities in the country. The earlier plan managed to bring 1Mbps broadband access to all municipalities in Brazil at low prices and led the way for many other telecommunications services and technologies to reach the population.

Brazil's IoT plan provides a basis for developing all IoT sectors, with a few priority areas chosen for acceleration based on country technical capabilities and likely demand. Many include the use of AI. Areas for acceleration include:

- **Smart Cities**: mobility, public safety, and utilities including smart metering;
- **Health**: IoT application to chronic disease management, prevention of epidemics, and improved efficiency and cost reduction in hospitals;
- **Rural**: efficient usage of natural resources, inputs and machinery, and sanitary safety;
- **Heavy Industry and Manufacturing**: process improvement, new equipment, product development, and new business model generation incorporating AI, IoT, and solutions integrating supply chains of goods, components, services, and inputs; and
- **Agriculture**: productivity improvements (with targets of up to 25 percent enhancement), reduction of inputs, especially pesticides and chemical fertilizers (with targets of reductions as high as 20 percent), and livestock management (e.g., eliminating human labor from monitoring animal weight).

3.5 Projects Profiled

Profiles of seventeen Brazilian ICT development projects are provided following (*Table 5*):

Table 5: ICT Development Projects – Brazil

Project	Sponsor
Terrestrial Communications Network Infrastructure: Telephone, Broadband, & Internet	
National 5G Laboratory	Centro de Pesquisa e Desenvolvimento em Telecomunicações (CPQD)
COMAER Public-Private Partnership (PPP)	Comissão de Implantação do Sistema de Controle do Espaço Aéreo (CISCEA)
Brazil 5G Auction	Agência Nacional de Telecomunicações (ANATEL)
Subsea Communications Infrastructure	
Seaborn Southern Hemisphere Subsea Cable Network: Seabras-1 to Recife	Seaborn Networks
Smart Cities and e-Government	
Curitiba Innovation Ecosystem – Vale do Pinhão Infrastructure Development Projects	Agência Curitiba de Desenvolvimento e Inovação
Curitiba Innovation Ecosystem – Vale do Pinhão Concession Development Opportunities	Agência Curitiba de Desenvolvimento e Inovação
Brazil's New e-Government Strategy	Secretariat of Digital Governance, Ministry of Economy
Public Sector IT Infrastructure Optimization Project (also *Data Centers and Cloud Computing*)	Secretariat of Digital Governance, Ministry of Economy
JRT Oasis Smart City	JRT Business Group
Angra dos Reis Smart City Public-Private Partnership (PPP)	Prefeitura de Angra dos Reis
Bridging Amapá's Digital Gap (also *Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband*)	Centro de Gestão da Tecnologia da Informação (PRODAP)
Project ES Digital (also *Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband*)	Instituto de Tecnologia da Informação e Comunicação do Espírito Santo (PRODEST)
Infovia Potiguar (also *Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband*)	Secretaria de Estado de Administração (SEAD)
Internet of Things (IoT) and Artificial Intelligence (AI)	
SemeAr AgTech Rollout	Centro de Pesquisa e Desenvolvimento em Telecomunicações (CPQD)
Center for Artificial Intelligence (AI) in Agroenergy	Parque Tecnológico Itaipu
AI Trends in Banking	FEBRABAN and ABFinTechs member companies
Yssy Acque Water Network Pilot	Yssy Soluções

NATIONAL 5G LABORATORY	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Internet and Broadband**
LOCATION	**Brazil**
PROJECT VALUE	**$25 Million (Initial Investment)**

PROJECT SUMMARY

Centro de Pesquisa e Desenvolvimento em Telecomunicações (Center for Research and Development in Telecommunications or CPQD), originally the R&D arm of Telebras, was set up as an independent not-for-profit foundation in 1998.

CPQD is proposing a national 5G laboratory for Brazil. 5G is the fifth-generation technology standard for cellular networks. The laboratory will carry out cybersecurity audits for all 5G solutions proposed for adoption in country. Envisioned as a multiuser laboratory, the proposed 5G laboratory will support government, industry, operators, and other 5G users. The laboratory will be incorporated as a not-for-profit foundation and governed by a management council, with input from a broad-representation advisory board. CPQD proposed the laboratory in response to ANATEL's public consultation on 5G cybersecurity in April 2020.

PROJECT BACKGROUND AND DESCRIPTION

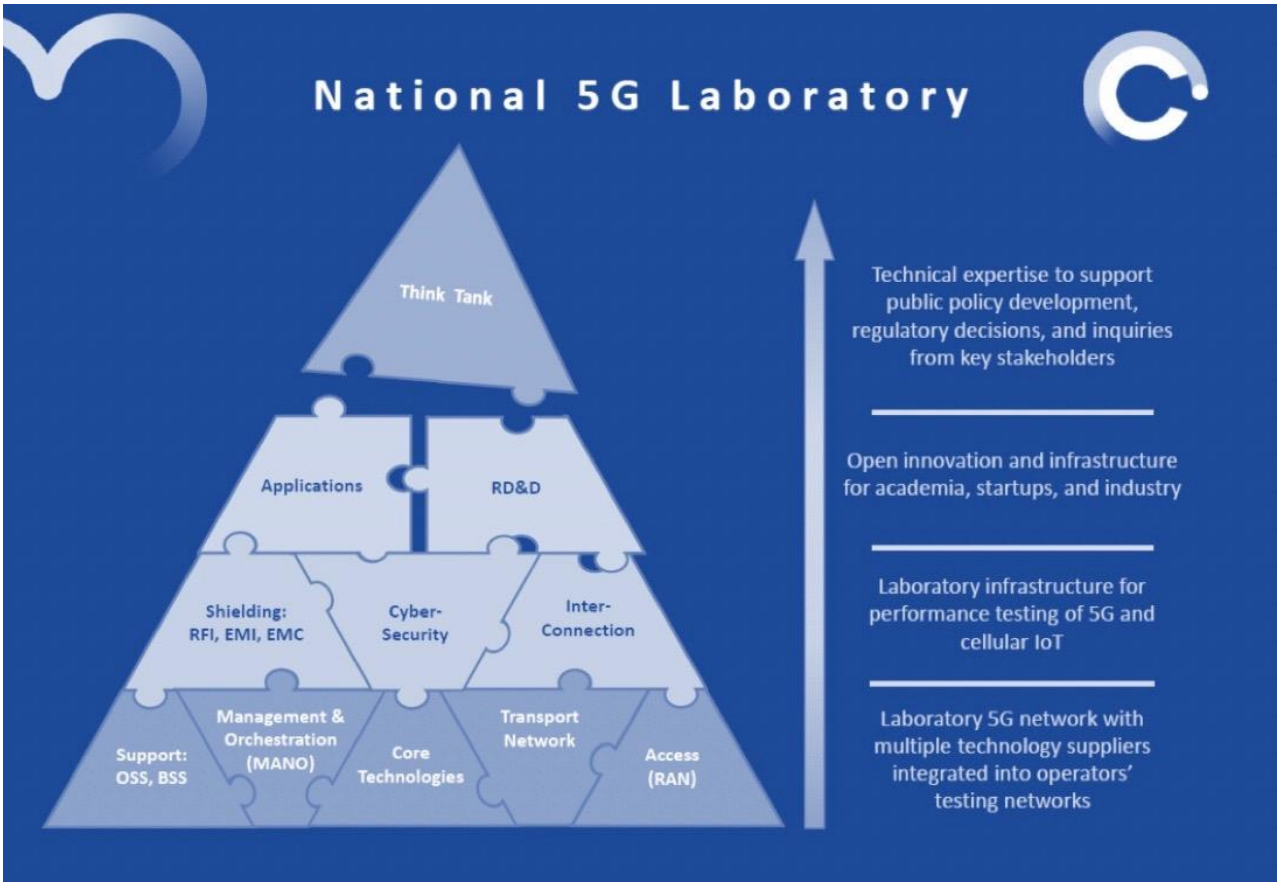
According to analyses presented at the World Economic Forum, 5G has the potential to permeate various industrial sectors and society itself, enabling global economic growth of an additional $13.2 trillion by 2035[19]. The Brazilian Ministry of Economy estimates the impact of 5G on the country's economic growth will be approximately $44 billion ($R250 billion) by 2035.[20] For these reasons, Brazil considers 5G to be a strategic technology in the digital transformation of many sectors of the economy and society, as well as a catalyst for the deployment of IoT applications.

Given the potential impact of this technology on the economy and society, particularly its strategic character under a digital transformation scenario, many countries have raised concerns regarding the cybersecurity of 5G networks. In Brazil, the Institutional Security Office of the Presidency of the Republic (GSI) established regulations for cybersecurity requirements in 5G networks; the regulations also specified an institutional framework for compliance and enforcement.

[19] World Economic Forum, "The Impact of 5G: Creating New Value across Industries and Society", Jan 2020.
[20] SEI Technical Note 15/2019 / SRM / SDI / SEPEC-ME.

Based on international examples, CPQD is proposing the creation of a national, multiuser 5G laboratory (*Figure 10).*

Figure 10: Conceptual Structure of the Brazilian National 5G Laboratory



The key objective for the laboratory is to guarantee the national capacity of equipment and solutions for cybersecurity audits of 5G networks is evolving as follows:

- Anatel, the Brazilian telecommunications regulator, and GSI have stated that 5G networks solutions should be subject to cybersecurity audits.
- Thus, CPQD understands it is mandatory for Brazil to have a national laboratory with infrastructure compatible with cybersecurity auditing requirements as specified by GSI and Anatel.
- The audit process will preferably involve the entire ecosystem of 5G technology actors.
- For this reason, CPQD is proposing a multiuser 5G laboratory.
- The available infrastructure (laboratory and human resources) can also serve as technical and consultative support for government, industry, operators, and 5G users.
- CPQD emphasizes that cybersecurity audit and compliance requirements will evolve in response to new risk scenarios that arise.

The CPQD proposal also postulates additional functions for the national 5G laboratory:

- The laboratory will include an end-to-end 5G network, implemented with solutions from all suppliers present in the country's networks, allowing cybersecurity testing on a network level, as well as component audits.
- The 5G laboratory network will also permit interoperability tests between equipment and solutions from different manufacturers. Such testing can establish opportunities and procedures for sharing infrastructure and slicing the network securely, even between systems of various service providers.
- The integration of this laboratory with the operators' laboratories will increase the ability to investigate security incidents and analyze real-time situations.
- The laboratory will also contribute to the National Education and Research Network Program's objectives, allowing the R&D institutions across Brazil to enjoy a real 5G network for experiments and proofs of concept.[21]
- The laboratory will also have the capacity to foster the development of 5G applications, reducing Brazil's technological asymmetry with countries that have invested in infrastructure solutions development.

For the State and industry, this laboratory will have an important role to serve as a testbed for conducting proofs of concept and validating applications linked to verticals that are highly relevant to Brazilian society, including Health, Education, Smart Cities, Industry 4.0, and Smart Agribusiness.

Governance of the laboratory will comprise two bodies:

- A Management Council including MCTIC, ANATEL, and GSI; and
- An Advisory Board with representatives from public and private sectors:
    - Ministries;
    - Operators;
    - ICT technology and solution providers;
    - Associations representing key user sectors;
    - Academia; and
    - Others as relevant.

Similar to CPQD, Brazil will incorporate the national laboratory as a not-for-profit foundation.

CPQD formally presented the National 5G Laboratory proposal to ANATEL in response to public consultation No. 9/2020 that closed on April 17, 2020. Despite initial press reports in January 2020 suggesting CPQD had formed a partnership with Huawei for this laboratory, no such partnership has been confirmed.

[21] Resolution No. 1 CATI / MCTIC of March 4, 2020

PROJECT STATUS AND IMPLEMENTATION TIMELINE

This project foresees its implementation and operation in incremental stages over three years:

- ***In the first year***, implement the entire laboratory infrastructure, and the support teams trained in the operation of tools and equipment. Begin projects to connect the laboratory to the external infrastructure elements participating in the initiative.
- ***The second year*** of operation, fulfill the demands for certification of solutions and equipment, provide support for national operators, and oversee the innovation initiatives supported by the laboratory.
- ***In the third year***, refine processes to begin the process of transition to an economically sustainable model.

PROJECT COST AND FINANCING

Over the first three years, CPQD estimates the need for an investment of $25 million.

Among the possible sources of financing for the project are private resources, contributed by telecommunications operators and equipment manufacturers operating in Brazil, and public funds from:

- The National Fund for the Development of Science and Technology (FNDCT),
- Fundo para o Desenvolvimento Tecnológico das Telecomunicações (the Fund Destined for the Technological Development of Telecommunication, or FUNTTEL), and
- Resources associated with the auction of radio frequencies, and others.

CPQD has also cited funding mechanisms being contemplated by the U.S. Congress for the USA Telecommunications Act.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies, in support of Brazil's National 5G Laboratory, include:

- 5G network capabilities and advisory services;
- 5G-specific cybersecurity systems, software, and advisory services;
- Network shielding and interconnection solutions;
- Cellular IoT applications;
- Personnel training and qualification advisory services; and
- 5G and IoT research and development advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Cláudia Piovesan Macedo Directorate of Innovation claudia@cpqd.com.br CPQD Parque II do Polo de Alta Tecnologia Campinas/SP Brazil www.cpqd.com.br	Gabrielle Mandel Country Manager, Latin America & the Caribbean LAC@ustda.gov Rodrigo Mota Country Representative, Brazil LAC@ustda.gov www.ustda.gov	Patricia Marega Commercial Specialist – IT, Telecom and Cybersecurity patricia.marega@trade.gov www.trade.gov

COMAER PPP	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Broadband, and Internet**
LOCATION	**Brazil**
PROJECT VALUE	**$1 Billion+**

PROJECT SUMMARY

- This project focuses on outsourcing the design, installation, operation, management, and maintenance of key elements of the communications, control, and management infrastructure of the communication networks of the Brazilian Air Force Command for a contractual period of 25 years.
- The networks support civilian communication, navigation, surveillance, and air traffic management across Brazil.
- COMAER will create a public-private partnership (PPP) to provide integrated network management services. The PPP will replace the 68 administrative contracts currently in force, with remuneration based on performance.

PROJECT BACKGROUND AND DESCRIPTION

Air navigation and airport management have undergone considerable restructuring in Brazil over the past decade. Since 1973, the state-held INFRAERO had managed the country's main commercial airports as well as portions of air navigation support. In 2010, Brazil opted for a concession model for commercial airport management.

In 2019, Brazil formed NAV Brasil as a public sector company, with its assets and personnel resulting from a partial spin-off from INFRAERO. The structure was suggested by the Brazilian military to maintain State control over air navigation. NAV Brasil is linked to the Ministry of Defense through the Air Force Command (Comando da Aeronáutica, or COMAER).

In parallel, COMAER searched for a mechanism to improve the management of the communication networks supporting air navigation. Geographically, these networks cover the whole of Brazil (*Figure 11*) and include:

- Operational wide area network (WAN);
- TELESAT WAN;
- Corporate WAN;
- Corporate metropolitan area network (MAN);

- Local area network (LAN) at the Santos Dumont Complex;
- TF-2 and TF-3 Telephone Networks;
- Aeronautical Command Telephone Network (Rede Telefônica de Comando do Comando da Aeronáutica or RTCAER);
- Air Navigation User Fee Collection System (Telecommunications Network for Sistema de Cobrança das Tarifas de Uso das Communicações e dos Auxilios à Navegação Aérea em Rota or SICOTAN);
- Central Atlantic Flight Information Region's (CAFSAT FIR's) very small aperture terminal (VSAT) network;
- DIGINET International Links used by the aeronautical message handling system (AMHS) and for communication with Civil Aeronautics Board (CAB)-Washington and CAB-Europe; and
- Integrated Management Center for Telecommunications Networks at COMAER.

Figure 11: Scope of COMAER Communication Networks

After assessing various alternatives, COMAER has determined a public-private partnership (PPP) to be the most appropriate mechanism to achieve greater efficiency and effectiveness in managing the communication networks. As precedent, the European Organization for the Safety of Navigation Aviation (Eurocontrol) and the United States Federal Aviation Administration (FAA) had reached similar decisions.

Branded as COMAER Integrated Communication Network (Gestão das Redes de Comunicações Integrada do COMAER or GRCIC), the project's intent is not to privatize the communication networks, but rather, to create a partnership in management, under the supervision and aligned with the needs of COMAER. COMAER has identified the following benefits from the PPP approach:

- Allows COMAER to focus on its core mission and activities;
- Achieves efficiency improvement (operations, human resources, and contracts);
- Optimizes contracting structure, from a starting point of 68 individual contracts;
- Applies economies of scale in procurement mechanisms;
- Increases responsiveness to meet new operational demands;
- Offers agility and flexibility in incorporating technological innovations;
- Improves budgetary control and forecasting; and
- Shares risks with the special purpose vehicle (SPV).

In summary, these benefits will improve communication network service, infrastructure, and responsiveness, while optimizing public-sector expenditure.

COMAER foresees that the PPP will be structured as an SPV by the consortium securing selection. The final step of the selection process is an auction whereby the qualified consortiums bid competitively for the key parameters of the performance-based remuneration scheme.

Implementation of the PPP contemplates various phases, including:

1. Assuming control of the communication network assets and contractual arrangements;
2. Implementing upgrades and optimization of the network and its contracts; and
3. Operating the network over two 10-year periods, including upgrading and refreshing the technology as required.

Key investments assigned to the SPV per the completed feasibility studies are:

- Communications equipment and network management systems;
- Testing and maintenance equipment, including spare parts, to guarantee the required service level agreements per site and per application;
- Implementation of the network and security operations centers (NOC and SOC);
- Support systems - energy, air conditioning, and security;
- Installation, testing, commissioning, and training services; and
- New applications and network modernization.

Principal operating costs for the SPV will include:

- Contracts with service providers;
- Operation of the NOC and SOC;
- Maintenance of equipment and associated infrastructure (including preventive/corrective, and remote/local maintenance);

- Logistic costs (spare parts, transport); and
- Associated technical personnel.

GRCIC specifies the entire set of investment and operational requirements over the 25-year project lifetime in a 433-page technical appendix to the tender package. Key considerations include mission-critical and administrative needs, involving air traffic projections, new applications, bandwidth optimization, and technology evolution.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Brazil completed project feasibility studies in 2017. The Federal Court of Accounts approved the project in August 2018.

The first bid and delivery guarantee session was held at Bovespa in June 2019. At the time, there were no interested parties.

The next session had been scheduled for May 2020 but was postponed due to the COVID-19 global pandemic. The process is expected to resume by the end of 2020, with the auction to occur during the first quarter of 2021. Updates to the process, over which the Comissão de Implantação do Sistema de Controle do Espaço Aéreo (CISCEA) has oversight, will be announced on the GRCIC web site, https://grcic.ciscea.gov.br.inicio,

PROJECT COST AND FINANCING

The contract values, over 25 years, based on published estimates at June 2019 prices[22] are:

- Revenues: $1.4 billion (BRL 5.27 billion);
- Investment expenditures: $0.4 billion (BRL 1.54 billion); and
- Operating costs: $0.6 billion (BRL 2.24 billion).

The PPP entity will obtain its revenues from the Federal Government according to a performance-based remuneration scheme. The entity will be responsible for securing implementation finance to cover the capital expenditures (CAPEX) required to upgrade the network. The feasibility study considers the following financing structure and costs (in nominal Brazilian Reais):

- 50 percent debt; 50 percent equity;
- 8.3 percent cost of debt;
- 15.4 percent cost of equity; and
- 11.8 percent weighted average cost of capital.

[22] Converted at June 2019 exchange rate: 1USD = 3.85BRL

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies for the COMAER PPP include:

- Air navigation network technology and associated hardware and software;
- Communications technology and associated hardware and software;
- Maintenance and spares infrastructure, inventory and management services;
- Support system technologies and associated hardware and control software - energy, air conditioning, and security;
- Installation, testing, commissioning, and training services; and
- Advisory services.

CONTACTS

Project Sponsor	U.S .Trade and Development Agency	U.S. Commercial Service
CISCEA has set up an e-mail account for all PPP inquiries: licitacaogrcic@ciscea.gov.br CISCEA Rio de Janeiro, Brazil https://grcic.ciscea.gov.br/inicio	Gabrielle Mandel Country Manager, Latin America & the Caribbean LAC@ustda.gov Rodrigo Mota Country Representative, Brazil LAC@ustda.gov www.ustda.gov	Genard Burity Commercial Specialist – Aviation and Airports genard.burity@trade.gov www.trade.gov

BRAZIL 5G AUCTION	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Brazil**
PROJECT VALUE	**License fees to be determined via auction. Infrastructure development cost in the billions.**

PROJECT SUMMARY

- The Brazil 5G auction will be the country's largest public sale of mobile licenses to date.
- Under the management of the regulator, ANATEL, the auction will award spectrum in the 700 MHz and 2.3 GHz and 3.5 GHz and 26 GHz bands for 4G and 5G, respectively.
- ANATEL published draft auction documents for public comment in February 2020.
- The previous auction timetable, originally scheduled for November or December 2020, has been postponed due to the COVID-19 global pandemic.

PROJECT BACKGROUND AND DESCRIPTION

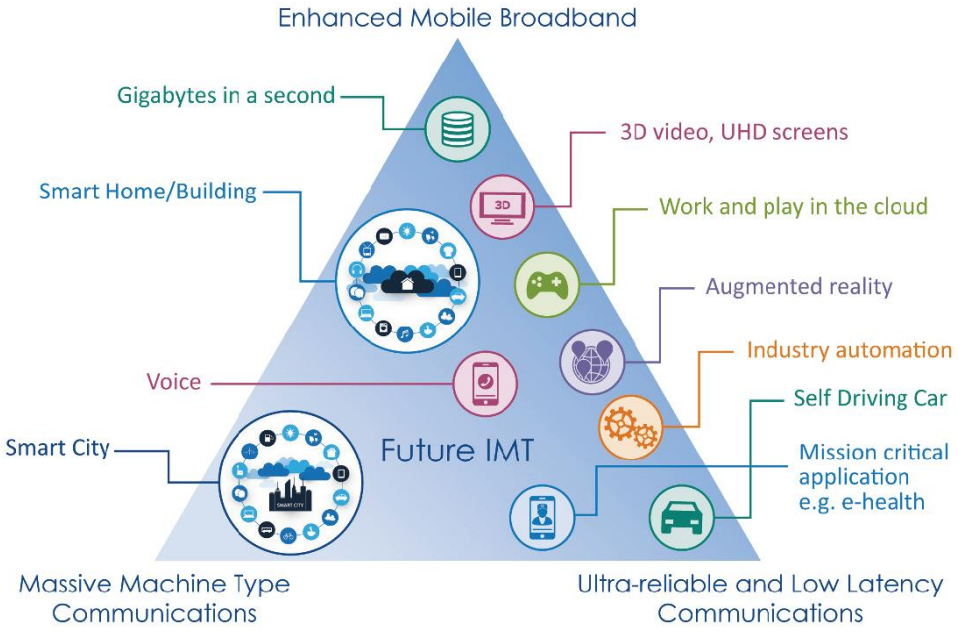
New services and business models for the digital economy have created ANATEL's justification for the Brazilian 5G auction. The higher data transfer speeds and lower latency of 5G technology will facilitate the creation of a new generation of smart cities and an IoT throughout the country. ANATEL cites the 5G rationale published by the International Telecommunications Union (ITU), which has defined three important use categories for 5G networks[23] (*Figure 12*):

- **Enhanced mobile broadband (eMBB)** – providing enhanced indoor/outdoor broadband and supporting enterprise collaboration, as well as augmented and virtual reality.
- **Massive machine-type communications (mMTC)** – enabling IoT, asset tracking, smart agriculture, smart cities, energy monitoring, smart home, and remote monitoring.
- **Ultra-reliable and low-latency communications (URLLC)** – enabling autonomous vehicles, smart grids, remote patient monitoring and telehealth, and industrial automation.

eMBB will enable high-speed streaming for in-home, screen, and mobile devices on demand; it will also facilitate a new generation of enterprise collaboration services. Therefore, many operators expect eMBB to be the primary use category for 5G in its early deployments. eMBB may also serve as the last-mile solution in those areas lacking copper or fiber-optic connections to homes.

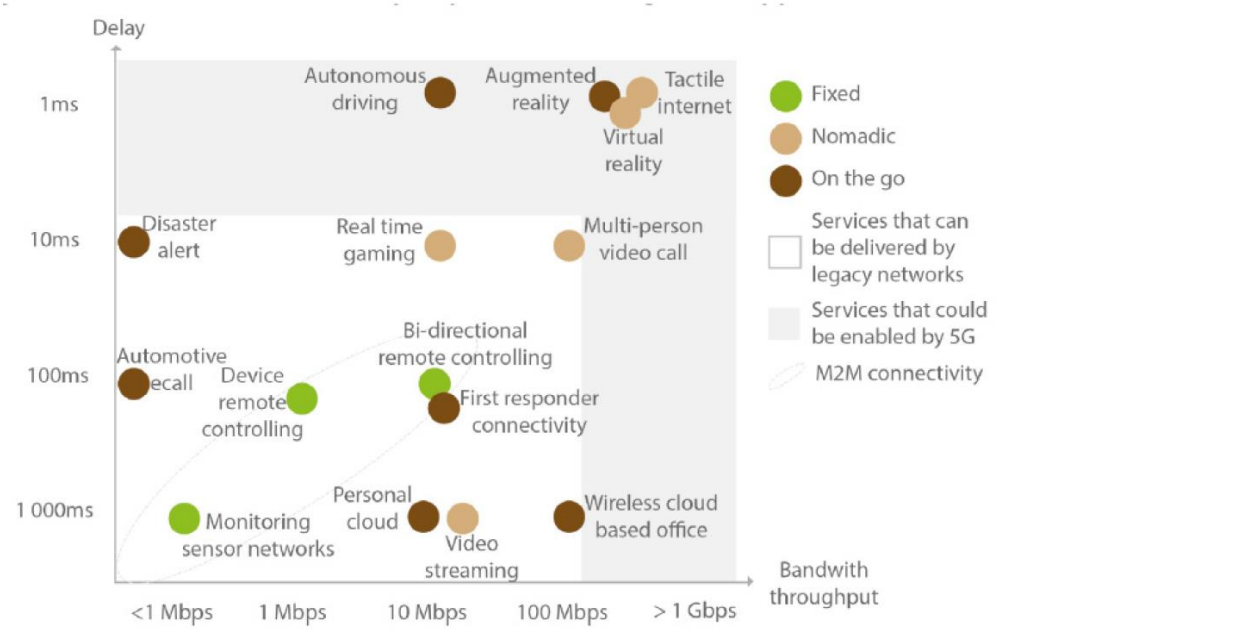
[23] ITU - Setting the Scene for 5G: Opportunities & Challenges, 2018

Figure 12: Mapping 5G Applications by Use Category



5G applications take advantage of a range of latency and speed requirements (*Figure 13*), some well in excess of 4G capabilities. Many 5G applications, in addition to utilizing the high speeds and low latency of the technology, will also require dense coverage, in contrast to the macro-cells that are common in 4G networks.

Figure 13: Mapping 5G Applications by Speed and Latency



ANATEL, in addition to justifying 5G technology, has explained its rationale for selecting its proposed auction mechanism, after considering the following alternatives:

- Simultaneous, multiple-round ascending auction;
- Combinatorial clock auction (CCA);
- Sealed bid auction; and
- Beauty contest.

The selection of the CCA mechanism is supported by several factors, including:

- Wide use by other countries in spectrum auctions;
- Benefits shown in academic research papers; and
- Publications from the U.S. Federal Communications Commission (FCC), including both studies and handbooks.

ANATEL has proposed specific rules and requirements for each of the four bands, described below:

700 MHz Band

- 20 MHz bandwidth (708 to 718 MHz and 763 to 773 MHz).
- Spectra unused after the 2014 4G auction.
- Commitment to expand network (4G or superior) to localities throughout Brazil that do not have mobile coverage:
  - 40 percent by the end of 2022;
  - 70 percent by the end of 2023; and
  - 100 percent by the end of 2024.
- Two bidding rounds:
  - The first round in blocks of 10 + 10 MHz, is limited to participants who do not already hold licenses in the 700 MHz band.
  - The second round in blocks of 5 + 5 MHz, with limitations on market share in the 700 MHz band.

2.3 GHz Band

- 90 MHz bandwidth (2,300 MHz to 2,390 MHz).
- Commitment to expand network (4G or superior) to 95 percent of consumers in municipalities with a population under 30,000:
  - 40 percent by the end of 2022;
  - 70 percent by the end of 2023; and
  - 100 percent by the end of 2024.
- Two bidding blocks:
  - 8 regional lots with 50 MHz bandwidth; and
  - 8 regional lots with 40 MHz bandwidth.
- Maximum 50 MHz bandwidth per licensee in this auction for the 2.3 GHz band.

- Specific technical provisions will be forthcoming to avoid potential interference in this band (especially with 2.4 MHz WiFi).

3.5 GHz Band

- 400 MHz bandwidth (3,300 MHz to 3,700 MHz).
- Two bidding rounds:
  - The first round in four sub-blocks:
    i. 8 regional blocks of 60 MHz limited to participants not holding licenses in regions where they are bidding;
    ii. 2 national blocks of 100 MHz;
    iii. 1 national block of 80 MHz; and
    iv. 8 regional blocks of 60 MHz limited to participants not awarded licenses in the prior sub-blocks.
  - The second round for any regional blocks of 60 MHz that are not assigned, dividing them into blocks of 40 and 20 MHz.
- Maximum 140 MHz bandwidth per licensee in this auction for the 3.5 GHz band.
- Some specific commitments and conditions apply to certain sub-blocks, including the installation of a fiber-optic backhaul transmission network.
- Licensees in the spectra between 3,625 and 3,700 MHz may have technical interference with free-to-air satellite television (TVRO) over the same frequencies. Filters may be used to resolve this interference. Alternatively, TVRO may migrate to the planned 12 GHz Ku band. The final auction documents will clarify a mechanism to resolve this dilemma.

26 GHz Band

- 3,200 MHz bandwidth (24.3 GHz to 27.5 GHz).
- Two bidding rounds:
  - The first round in two sub-blocks:
    i. 5 national blocks of 400 MHz; and
    ii. 21 regional blocks of 400 MHz.
  - The second round for any unassigned sub-blocks, up to 10 national blocks of 200 MHz, and up to 42 regional blocks of 200 MHz.
- Maximum 1,000 MHz bandwidth per licensee in this auction for the 26 GHz band.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Each of the four bands in the Brazilian 5G auction has different requirements for their implementation timelines, as described above.

ANATEL published its draft auction documents in February 2020. By the closing of the public comment period in April, the regulator had received 244 comments. As the COVID-19 global pandemic commenced during the commenting period, many operators indicated they were focused principally on responding to the health crisis and requested the auction be postponed.

When ANATEL published the draft auction documents in February, the indicative calendar showed the auction would be held at the end of 2020. ANATEL has not issued a new timeline for the auction process. Industry sources suggest that the auction will be held during the first half of 2021.

Regardless of the eventual auction date, the next steps in the process will be:

- Approval of final auction documents;
- Publishing of final auction documents;
- Deadline for submittal of proposals; and
- The spectrum auction.

PROJECT COST AND FINANCING

Each operator awarded spectra from the auction will be responsible for building its network and obtaining its own implementation finance.

ANATEL has not published an estimate of license fees, although it did publish international benchmarks of $0.09 per MHz per capita and $4.3 million per MHz per 10-year period for the 3.5 GHz band, considered the prime frequency for 5G. ANATEL also warns of using such a benchmark:

> *"It should be interpreted with caution, considering the diversity of the markets, the difference in consumer purchasing power, and the particularities of each competitive process in the mentioned countries."*

Applying the benchmark to the 400 MHz of spectrum in the 3.5 GHz band (and considering Brazil's large population) yields a total band licensing fees estimate between $3 and $7 billion. Since Brazil will auction three other bands, it appears possible that the proceeds from Brazil's 5G auction will be even larger than the 700 MHz (4G) auction of 2014, which yielded about $2.5 billion (BRL 5.85 billion).

U.S. EXPORT OPPORTUNITIES

In addition to competing for spectrum licenses, export opportunities for U.S. companies in conjunction with Brazil's 5G auction will include:

- Fiber optic network backhaul hardware, software, and installation and maintenance services;
- Small- and pico-cell, low-power base station hardware, software, and installation and maintenance services;
- Multiple-input/multiple-output (MIMO) technology, antenna modules, and installation, maintenance, and advisory services;
- Beamforming technology and advisory services;

- Centralized radio network (C-RAN) technology, baseband unit hardware and software, and advisory services; and
- Giga-bit WiFi technology, hardware, software, and advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SEABORN CABLE NETWORK: SEABRAS-1 to RECIFE	
SUBSECTOR	**Subsea Communications Infrastructure**
LOCATION	**Brazil**
PROJECT VALUE	**$50 Million**

PROJECT SUMMARY

Seaborn is an independent ICT infrastructure developer. The company is focused on developing and expanding its presence in Central America, South America, and the Caribbean. Current activities under its Southern Hemisphere subsea cable network strategy include:

- Extension of the company's Seabras-1 cable, connecting Brazil and the United States, to Recife, Pernambuco
- Development of a subsea fiber-optic cable system between Mexico and the United States (MexUS)
- Development of a new Caribbean subsea fiber-optic cable system, which will also link to Seabras-1 and the MexUS cables.

The Seabras-1 to Recife project includes the development and operation of a 500 km extension of Seaborn's Seabras-1 subsea fiber optic cable into Recife, Pernambuco state, in the northeast of Brazil. Reliable international connectivity and an economically-viable connection to southern Brazil will markedly enhance ICT capabilities for the technology-focused state of Pernambuco. The project also will provide connectivity for surrounding Brazilian states, thus boosting the economic development of northeast Brazil. Seaborn expects to begin construction during 2020.

PROJECT BACKGROUND AND DESCRIPTION

Seaborn, headquartered in Beverly, Massachusetts, USA, is an independent infrastructure developer of subsea fiber optic cable systems and related ICT assets. The company fully operates and maintains its submarine cable system, landing stations, terrestrial backhaul, points of presence (PoPs), and metro connectivity. Seaborn also owns and operates primary and disaster recovery network operations centers (NOCs). Its mission is to address global communications needs between South and North America for carriers, OTTs (over-the-top telecommunications providers), ISPs (internet service providers), HFTs (high-frequency trading financial services), enterprises, and governments.

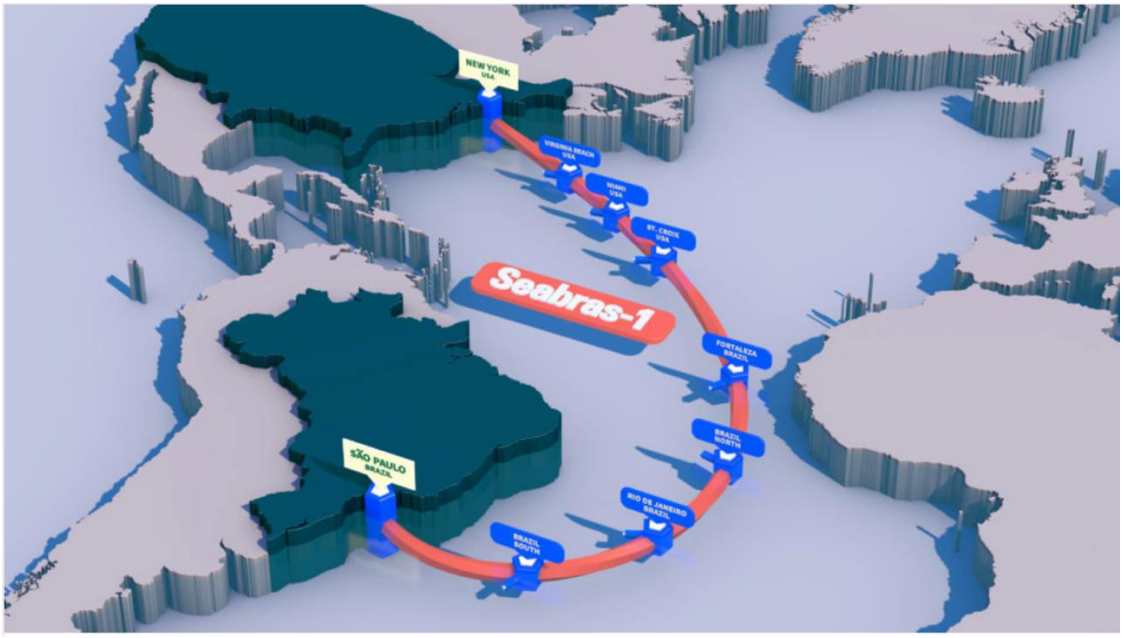
The company's Seabras-1 cable was completed in 2017. It provides direct PoP to PoP (Point of Presence) service from New York to São Paulo, landing in Brazil at Seaborn's Praia Grande landing station. Seabras-1 features six fiber pairs operating at 72 terabytes per second (Tbps) and

was built by Alcatel Lucent. Associated terrestrial routes in Brazil were all built as buried to enhance security. The cable was built with 161 repeaters and multiple branching units including (*Figure 14*):

- Virginia Beach, VA;
- Miami, FL;
- St. Croix;
- Fortaleza, Brazil;
- Brazil North;
- Rio de Janeiro; and
- Brazil South.

The company also owns fiber infrastructure on AMX-1, a cable system connecting Rio de Janeiro and Jacksonville, Florida, USA

Figure 14: Seabras-1 Subsea Fiber Optic Cable Map



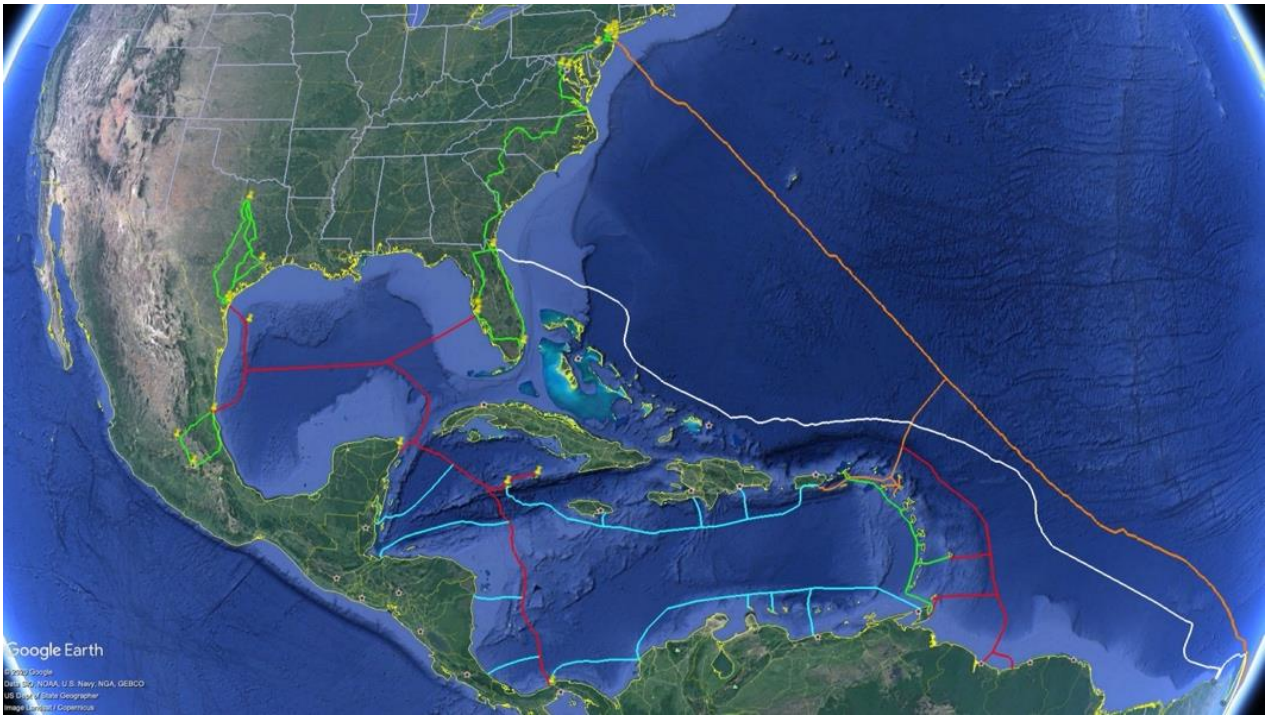
Seaborn has recently commenced three major infrastructure projects aimed at extending ICT capabilities across the Americas:

1. **Extension of the company's Seabras-1 cable, connecting Brazil and the United States, to Recife, Pernambuco** – the project will provide more efficient and cost-effective connectivity for northeastern Brazil.
2. **MexUs Cable** - this project will provide core connectivity among the United States, Mexico, Grand Cayman, and Panama, enabling onward connectivity to existing subsea and terrestrial ICT networks.

3. **Caribbean System** (Caricom and Central America) - this development-stage project is a new, Caribbean-region-wide network intended to replace limited bandwidth, 20-year-old ICT infrastructure.

The interconnection of the Seabras-1 cable with these new assets will provide a modern, high-capacity communications network offering substantial connectivity improvement and cost reduction across the Latin American/Caribbean region (*Figure 15*).

Figure 15: Project Map – The Combined Seaborn Americas Network



In Brazil, Seaborn is in the late development stages of the project to extend its Seabras-1 subsea line into Recife in the Northern Brazilian state of Pernambuco (*Figure 16*). This cable will run 500 km from the Seabras-1 cable into Recife. It is designed as a two-fiber pair, 12 Tbps cable.

In addition to the cable extension, the project includes a new, Tier 3 data center, to be constructed to serve the City of Recife and the State of Pernambuco. The data center will house the cable landing station equipment for the subsea extension from Seabras-1. The data center will be located 4 km from 'Porto Digital,' a hub for the information technology industry created by the municipality of Recife and the Pernambuco state government. Porto Digital hosts over 300 companies and 10,000 employees within its campus environment. The delivery of international connectivity directly into Recife is critical ICT infrastructure for the future growth of the campus, as well as the region as a whole, for ICT products and services.

Figure 16: Extension of Seabras-1 Cable to Recife

The State of Pernambuco is the hub of manufacturing in northeastern Brazil. Its industrial base includes shipbuilding, automotive parts, petroleum refining, petrochemical production, metals processing, and electronics.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Seaborn Recife cable and data center are in the late stages of development. Project implementation will commence in Q4 2020. Seaborn is working closely with a local partner, with whom the project is currently in the design and contracting stages. Award of required contracts will begin in Q4 2020, with a ready for service date (RFS) date of Q4 2021, though the COVID-19 global pandemic may protract this estimate.

PROJECT COST AND FINANCING

The expected investment for the Seabras-1 to Recife fiber-optic cable and associated data center will be approximately $50 million (250 million Brazilian reais). The project will be 100 percent funded by the local partner using 50 percent equity (self-funded) and 50 percent debt through a regional development bank, assuming timing estimates are met.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. firms include:

- Fiber optic cabling hardware;
- Fiber optic network management hardware and software;
- Network modeling, design, and engineering services;
- Ship services/oversight;
- Installation/testing services/oversight; and
- Other technical and management advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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CURITIBA INNOVATION ECOSYSTEM – INFRASTRUCTURE	
SUBSECTOR	**Smart Cities / e-Government**
LOCATION	**Brazil**
PROJECT VALUE	**$228 Million+**

PROJECT SUMMARY

- In 2017, the City of Curitiba adopted a five-pillar strategy, Vale do Pinhão, to accelerate the implementation of smart city projects within the municipality.
- Infrastructure projects currently active/included in Vale do Pinhão include improving public transit capacity and velocity, developing an innovation hub, and building a security-enhancing digital wall.
- The project sponsor is Agência Curitiba de Desenvolvimento e Inovacão (the Curitiba Agency for Development and Innovation).

PROJECT BACKGROUND AND DESCRIPTION

In 2017, the City of Curitiba adopted a strategy to accelerate Smart City project implementation within the municipality. Known as "Vale do Pinhão" (Pine Nut Valley), the strategy incorporates five pillars to integrate the municipal government with the diverse stakeholders in the city's economic ecosystem; companies, universities, non-profit organizations, and citizens.

Vale do Pinhão's five pillars are:

- Re-urbanization and Sustainability;
- Education and Entrepreneurship;
- Technology;
- Legislation and Tax Incentives; and
- Integration and Articulation

The Vale do Pinhão pillars are aligned with the United Nations' (UN's) Sustainable Development Goals and extend beyond efforts supporting purely economic growth. The pillars interconnect several projects City Hall is developing to accelerate positive transformations in the urban landscape, engage the community in this participative movement, embrace new technologies, and allow the city to better adapt to future challenges.

Curitiba's most significant Smart City projects address inclusion and integration, focusing on innovation, mobility, and information and communications technologies (ICT). Four current Vale do Pinhão Smart City infrastructure development initiatives include:

1. Increasing Capacity and Velocity of Inter2 Bus Route
2. Increasing Capacity and Velocity of BRT East-West and South Axis
3. Hub of Innovation (Escher Building)
4. Curitiba's Digital Wall

The other two initiatives are described in the *Concessions* profile following:

- Public-Private Partnership Concession for Street Lighting Modernization
- Concession of Mobility Services

1. Increasing Capacity and Velocity of Inter2 Bus Route

Increasing the Inter2 bus route's capacity and velocity is one of Curitiba's initiatives to improve urban mobility by increasing the number of passengers using the public transit system. The project includes:

- Integration among different modes of transportation;
- Efficiency of operations; and
- Bus station and terminal accessibility for pedestrians and people with reduced mobility (*Figure 17*)

Figure 17: Renderings of Inter2 Station Projects[24]

The first component of the project is improving road infrastructure, whose steps include:

1. Implementing of exclusive or preferential road infrastructure along the Inter2 route, totaling approximately 60.9 km,
2. Integrating public transit terminals to the systems operating throughout Paraná State,
3. Constructing integration for the public transit system along the Inter2 route,

[24] Curitiba City Hall, Mayor's Office for International Affairs

4. Implementing plans to mitigate social and environmental impacts, expropriations, and compensation for temporary impacts to local businesses, and
5. Technical supervision.

Road infrastructure works, including the design of secondary routes and those necessary for implementing dedicated bus lanes, will be divided into six lots, encompassing projects and civil works. The exclusive and preferred roads will be updated with new layouts, the replacement of asphalt pavement, and provision/replacement of vertical and horizontal signage. The initiative also includes improving secondary streets with new landscaping, sidewalks, lighting, and accessibility.

The second component centers on innovation and new technologies, with actions aimed at:

1. Use of Building Information Modeling (BIM) in the management of the project's construction contracts.
2. Modernization of system management by:
    a. Expanding the operations control center,
    b. Developing and implementing commercial strategies to strengthen the transit system's non-ticket revenues, thus reducing dependence on ticket sales,
    c. Conducting behavioral studies and experiments to identify measures and means to motivate citizens to use the public transit system,
    d. Developing and implementing data-exchange standards for single-payment for multiple rides, connection of multiple accounts, and use of multimodal planning tools, and
    e. Defining standards, incentives, and conditions for low-carbon rolling stock and developing a new compensation mechanism for system operators.
3. Financing the application of the Walkability Index's gender-sensitive methodology (including creating awareness campaigns to prevent violence against women).

The resulting system will assist the city in dealing with ongoing changes related to travel patterns and preferences, as well as provide a functional and adaptive service for users based on improved information acquisition and connectivity.

In addition to the deliverables described for the components above, the project will include:

- Management, including the hiring of professionals to strengthen the contractor's team in environmental and technical aspects,
- Monitoring and evaluation, and
- External financial audit as necessary.

2. Increasing Capacity and Velocity of BRT East-West and South Axis

Increasing capacity and velocity of BRT East-West and South Axis, like the prior initiative, is targeted to increase the number of people using Curitiba's public transit system while discouraging

individual modes of transportation. Greater mobility, combined with the optimization, expansion, and requalification of the infrastructure, will also improve the socio-economic conditions of communities living near the areas covered by this initiative. Project components include:

- *Restructuring Lanes* - improvements to the pavement with passageways in the corridors, Greenroads® certification, traffic light priority, signage, landscaping, accessibility, improvements to stations with intermodal integration (especially micro-mobility), and implementation of the Safe System as part of educational programs.

- *Pavement Restructuring East-West Corridors* - pavement restructuring with concrete across these corridors, which encompass 66 bus stops over a 22.5 km of pavement, ten stations with two traffic directions, and 23 covering passageways. An additional, proximal 10.2 km of secondary streets will undergo pavement restructuring.

- *Addition of Concrete Pavement for Stations in the South Corridor* - this corridor includes 26 bus stops over 7.5 km. Contractors will apply concrete pavement near the stations, and nine merging stations, as well as another four with drive-through passageways, will be added.

- *Bus Terminal Infrastructure Improvement* - of the four bus terminals included in the project, two will undergo infrastructure improvements, the third will be rebuilt in the same location, and a fourth will be built in a new area to improve integration with the East-West corridor.

The city estimates roughly 30 percent of subprojects will require new development, with the remaining 70 percent updating existing infrastructure. Renderings of updated infrastructure are provided (*Figure 18).*

Figure 18: Renderings of BRT East-West and South Axis Infrastructure Improvements[25]

[25] Ibid

3. Hub of Innovation (Escher Building)

The Escher Building, originally constructed as a flour mill, is an icon of Curitiba's old industrial district (*Figure 19*). Long unused, the building will be repurposed and transformed into a green and smart structure: The Hub of Innovation (*Figure 20*). To be LEED (Leadership in Energy and Environmental Design) Platinum certified, the Hub of Innovation will feature an open-space roof allowing for natural lighting, systems to reuse rainwater, and solar photovoltaic (PV) panels.

The Innovation Hub will be the centerpiece to represent Vale do Pinhão's ecosystem in one place, where entrepreneurs, startups, tech companies, universities, and other organizations connected to the movement can gather and share ideas. The building encompasses 2,179 square meters and a local architecture firm hired by City Hall is tasked with design. The building will feature a co-working space, a startup accelerator and incubator, a research center, and a fabrication lab.

Figure 19: The Escher Building[26]

Figure 20: The Hub of Innovation as Envisioned – Exterior and Interior[27]

[26] Ibid
[27] Ibid

4. Curitiba's Digital Wall

Curitiba's Digital Wall is a project intended to increase security within the municipality. It is viewed as imperative by the Secretariat of Social Defense and Public Security. The project's goal is to provide security process improvements in traffic management, public transportation, preventive security, civil defense, and social assistance. The Digital Wall will allow security data analysis through real-time processing of information collected by video monitoring devices. The Digital Wall integrates high-speed cameras and high-quality private-owned cameras.

The Digital Wall will integrate and expand several extant city monitoring systems by combining a fiber-optic network and a new Monitoring Center. 488 new cameras will be added to 697 units already in operation to increase coverage and efficiency. Cameras are and will be installed in streets, public transportation facilities, and public squares. In addition, municipal schools, public squares, highways, and other facilities will install 185 security panic buttons.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project status and implementation timeline for each of the Vale do Pinhão projects is described below:

1. Increasing Capacity and Velocity of Inter2 Bus Route

Several parts of this project are currently open for bid. The Brazilian Senate already has authorized a credit facility under Resolution N. 7/2020, with federal guarantees. The city of Curitiba plans to sign the credit operation contract in November 2020. Additional bids will follow with work beginning during the first half of 2021. Project completion is expected in the 2024-5 timeframe.

2. Increasing Capacity and Velocity of BRT East-West and South Axis

This project has received authorization from the External Financing Commission, under Resolution 01/0140/2020. Negotiations are in process with the financing entity, the New Development Bank (NDB). Bids have already begun for two elements of South Corridor work, with contract award expected shortly. Project completion is expected in the 2024-5 timeframe.

3. Hub of Innovation (Escher Building)

The Hub of Innovation executive projects will be ready at the beginning of 2021, followed by a public bidding process for implementation steps. After completion, scheduled for the second semester of 2022, the Escher Building will be available to new investment and partnership opportunities.

4. Curitiba's Digital Wall

The Digital Wall project began on June 26, 2020, with the signing of a partnership between City Hall and the Instituto das Cidades Inteligentes (ICI). Implementation includes building the video monitoring center facilities within the first 90 days of the project (Phase 1). Within 180 days (Phase 2), 488 video surveillance cameras and 185 panic buttons will be installed at locations defined by the contract. Hiring, training, and qualification of a security team are also included.

PROJECT COST AND FINANCING

The Vale do Pinhão projects have an aggregate value of $3.4 billion, including the two lengthy (15- and 20-year) concessions described in the *Concessions* project profile. The Vale do Pinhão infrastructure projects represent an investment of at least $228 million. Details concerning project cost and financing for each of the four infrastructure projects are provided below:

1. Increasing Capacity and Velocity of Inter2 Bus Route

The total budget for Increasing the Capacity and Velocity of the Inter2 Bus Route is $133.4 million. The budget is segmented by project element, with civil works and supervision comprising the majority of expected expenditures (*Table 6*).

Table 6: Project Budget – Increasing the Capacity and Velocity of the Inter2 Bus Route[28]

Deliveries	IDB (US$ M)	City (US$ M)	Total
1st Component Civil works and supervision	95.6	26.7	122.3
Roads infrastructures	76.5	15.5	92.0
Transit Integration Terminals	0.8	8.6	0.8
Bus stations	4.9	-	4.9
Artworks	4.5	0.5	5.0
Environmental and social management, compensation and real estate acquisition	3.8	10.6	14.4
Works' Supervision	5.1	-	5.1
2nd Component Innovation and new technologies	2.5	-	2.5
BIM for management and administration	1.0	-	1.0

[28] Ibid

Operations Control Center	1.0	-	1.0
Studies and development of applications and technologies	0.5	-	0.5
Project management and administration	13.3	-	13.3
Environmental Supervision	3.3	-	3.3
Monitoring and evaluation	0.6	-	0.6
Total	**106.7**	**26.7**	**133.4**

The Inter-American Development Bank (IDB) has secured associated funds. The city is expected to sign the credit operation contract in November 2020, which has already been authorized by the Brazilian Senate, via Resolution No. 7/2020, with guarantees conferred by the Federative Republic of Brazil.

2. Increasing Capacity and Velocity of BRT East-West and South Axis

The total budget for increasing the capacity and velocity of BRT East-West and South Axis is $93.75 million (*Table 7*). The project budget is segmented to support several key tasks, with tasks 1 to 5 and 9, or nearly two-thirds of the budget, available for competitive international bidding. Consulting support, representing seven percent of the project budget, will be selected based on quality and cost.

3. Hub of Innovation (Escher Building)

The Hub of Innovation's estimated initial budget is BRL 2.5 million ($470,000), with financing sourced from Caixa Econômica Federal. In the second half of 2022, after completion of construction, new investment and partnership opportunities will become available for the Hub's operations and projects.

4. Curitiba's Digital Wall

No budget has yet been established for the Curitiba Digital Wall.

Table 7: Project Budget – Increasing the Capacity and Velocity of BRT East-West and South Axis[29]

BIDDING NUMBER	CONTRACT DESCRIPTION	Estimated Value (Millions US$)	ACQUISITION METHOD
OBRAS		**87,000,000.00**	
1	Remodeling the dedicated BRT lanes (East/West - Lot 01 – Stretch between the future North CIC Terminal and Campina do Siqueira Terminal Deployment of North CIC Station Deployment of UTFPR Station	10,600,000.00	International Competitive Bidding (ICB)
2	Remodeling of the decicated BRT lanes East/West - Lot 02.01 – Stretch between the Campina do Siqueira Terminal and Rui Barbosa Square (Road Infrastructure) Remodeling of the decicated BRT lanes East/West - Lot 02.02 – Stretch between the Campina do Siqueira Terminal and Rui Barbosa Square (Traffic Lights) Remodeling of the decicated BRT lanes East/West - Lote 02.03 – Strech Between Mal. Floriano Peixoto Avenue and Rua Tibagi on Sete de Setembro Avenue and between Rua Tibagi and Rua Schiller on Afonso Camargo Avenue Relocation and Expanding of Eufrásio Correia Station	16,350,000.00	International Competitive Bidding (ICB)
3	Remodeling the dedicated BRT lanes (East/West - Lot 03 – Stretch between Rua Schiller and the border with the city of Pinhais on Afonso Camargo Avenue. Surroundings of Capão da Imbuia Terminal (Rua Mota Machado)	14,350,000.00	International Competitive Bidding (ICB)
4	Remodeling of the decicated BRT lanes East/West - Lot 4.1 – Strech Between Rua Eng. Costa Barros and Rua Filipinas Remodeling of the decicated BRT lanes East/West - Lot 4.2 – Stretch between Rua Ceilão and Rua Sebastião Marcos Luiz Reform and Expansion of Centenário Terminal Reform and Expansion of Vila Oficinas Terminal	10,200,000.00	International Competitive Bidding (ICB)
5	Binary Nivaldo Braga X Olga Balster	9,300,000.00	International Competitive Bidding (ICB)
6	Remodeling of the decicated BRT lanes SOUTH - Lot 10.1 - Stretch between Praça do Japão and Pinheirinho Terminal Remodeling of the decicated BRT lanes SOUTH - Lot 10.2 - Stretch between Praça do Japão and Pinheirinho Terminal	5,000,000.00	National Competitive Bidding (NCB)
7	Remodeling of the decicated BRT lanes SOUTH - Lot 10.3 - Stretch between Praça do Japão and Pinheirinho Terminal	3,800,000.00	National Competitive Bidding (NCB)
8	Reconstruction of Campina do Siqueira Terminal - Demolition and reconstruction of a new Terminal (on the same land)	5,000,000.00	National Competitive Bidding (NCB)
9	New Capão da Imbuia Terminal (construction of new terminal in another land)	7,900,000.00	International Competitive Bidding (ICB)
10	Capão da Imbuia Terminal (Expropriation)	4,500,000.00	National Competitive Bidding (NCB)
CONSULTING		**6,750,000.00**	
11	Labor Supervision	4,800,000.00	Quality and Cost Based Selection (QCBS)
12	Program Management Support	200,000.00	Quality and Cost Based Selection (QCBS)
13	Management and Environmental Supervision	100,000.00	Quality and Cost Based Selection (QCBS)
14	Studies and Assessments	150,000.00	Quality and Cost Based Selection (QCBS)
15	**Project Elaboration**	**1,500,000.00**	Quality and Cost Based Selection (QCBS)
TOTAL DOLLARS $		**93,750,000.00**	

[29] Ibid

U.S. EXPORT OPPORTUNITIES

A variety of Vale do Pinhão export opportunities exist for U.S. companies (*Table 8*).

Table 8: U.S. Export Opportunities – Vale do Pinhão infrastructure Projects

Vale do Pinhão Project	U.S. Export Opportunities
1. Increasing Capacity and Velocity of Inter2 Bus Route	• Station-related ICT hardware • Station and management software • Consulting - operations, social science
2. Increasing Capacity and Velocity of BRT East-West & South Axis	• ICT hardware and sensors • Control and management software • Consulting - operations, environmental
3. Hub of Innovation (Escher Building)	• Consulting – LEED • Participation in Innovation Hub projects
4. Curitiba's Digital Wall	• ICT hardware – cameras, sensors • ICT software – apps, systems operation • Consulting – training and certification

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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CURITIBA INNOVATION ECOSYSTEM – CONCESSIONS	
SUBSECTOR	**Smart Cities / e-Government**
LOCATION	**Brazil**
PROJECT VALUE	**$3.2 Billion ($205 Million Annually)**

PROJECT SUMMARY

- In 2017, the City of Curitiba adopted a five-pillar strategy, Vale do Pinhão, to accelerate the implementation of smart city projects within the municipality.
- Concession projects currently active/included in Vale do Pinhão include a smart street lighting public/private partnership and the concession of mobility services.
- The project sponsor is Agência Curitiba de Desenvolvimento e Inovacão (the Curitiba Agency for Development and Innovation).

PROJECT BACKGROUND AND DESCRIPTION

In 2017, the City of Curitiba adopted a strategy to accelerate Smart City project implementation within the municipality. Known as "Vale do Pinhão" (Pine Valley), the strategy incorporates five pillars to integrate the municipal government with the diverse stakeholders in the city's economic ecosystem; companies, universities, non-profit organizations, and citizens.

Vale do Pinhão's five pillars are:

- Reurbanization and Sustainability
- Education and Entrepreneurship
- Technology
- Legislation and Tax Incentives
- Integration and Articulation

The Vale do Pinhão pillars are aligned with the United Nations' (UN's) Sustainable Development Goals and extend beyond efforts supporting purely economic growth. The pillars interconnect several projects City Hall is developing to accelerate positive transformations in the urban landscape, engage the community in this participative movement, embrace new technologies, and allow the city to better adapt to future challenges.

Curitiba's most significant Smart City projects address inclusion and integration, focusing on innovation, mobility, and information and communications technologies (ICT). Two current Vale do Pinhão Smart City concessions initiatives are described following:

1. Public-Private Partnership for Street Lighting Modernization
2. Concession of Mobility Services

The four other initiatives are described in the *Infrastructure Development* profile preceding:

- Increasing Capacity and Velocity of Inter2 Bus Route
- Increasing Capacity and Velocity of BRT East-West and South Axis
- Concession of Mobility Services
- Hub of Innovation (Escher Building)
- Curitiba's Digital Wall

1. Public-Private Partnership for Street Lighting Modernization

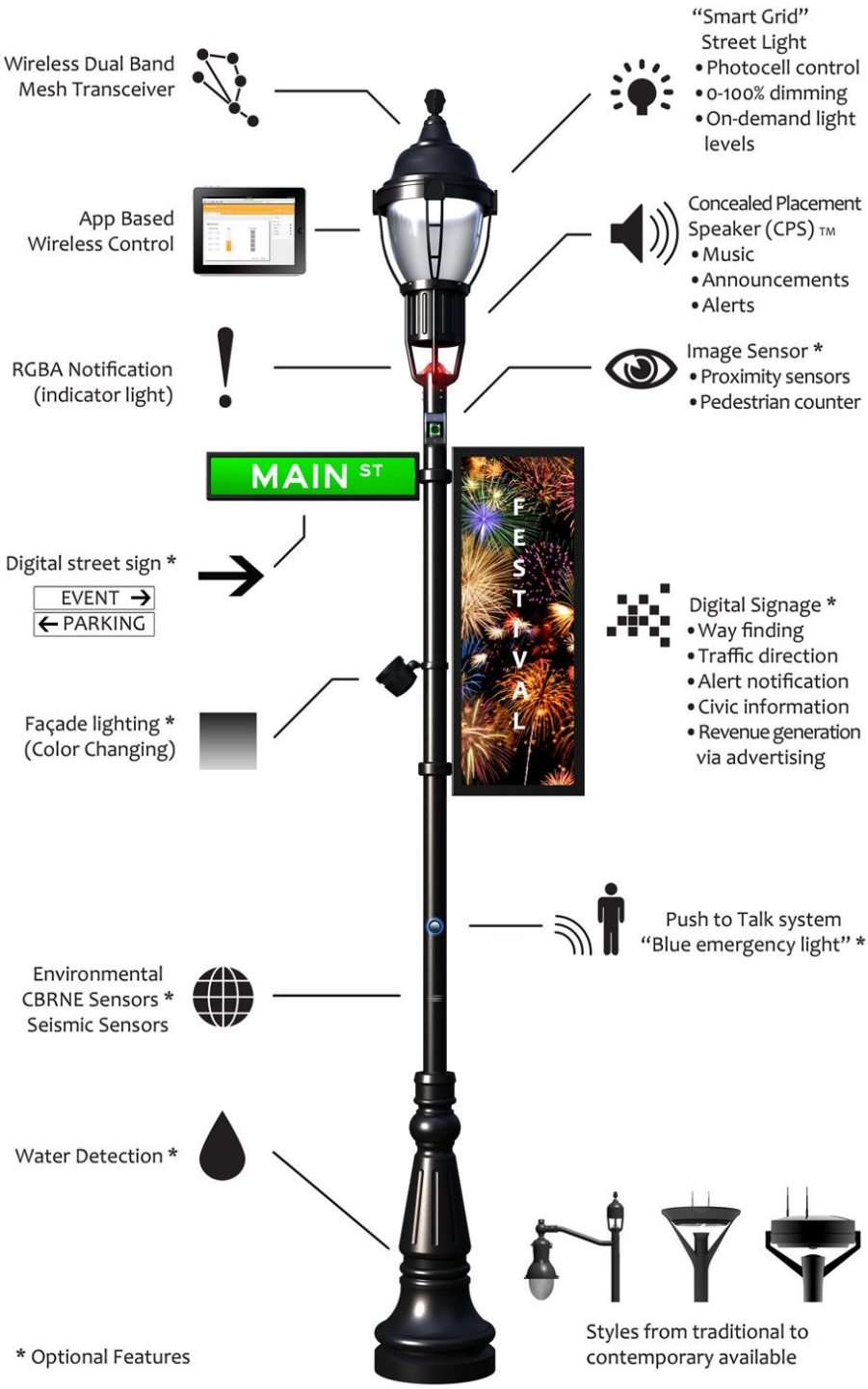
A public-private partnership (PPP) will modernize Curitiba's public lighting system with the objectives of expanding and improving the efficiency of the current system. The project plan includes converting the 160 thousand conventional lamps currently in service to LED units, with the following benefits:

- As much as 50 percent savings in energy costs,
- A new Operations Control Center for management/maintenance speed and efficiency. and
- Improved quality of service to residents.

Smart street lighting offers the opportunity to provide a range of services beyond lighting (*Figure 21*). An important aspect of this project is creating new revenue streams based on these capabilities beneficial for all partners. Hence, the city is studying alternatives to allow each lamppost to become a hub for Internet of Things (IoT) solutions, as well as electric charging stations. IoT applications under consideration include installing sensors to capture:

- Rain levels
- Humidity
- Air quality
- Wind velocity
- Ambient temperature
- Noise levels
- Traffic monitoring

Figure 21: How a Smart Streetlight Works[30]



[30] Intellistreets

2. Concession of Mobility Services

Over the past five years, new transportation services have changed metropolitan transportation dynamics in Curitiba. Flexible platforms like Uber, Cabify, 99, and BlaBla Car, along with shared bicycles and scooters, run parallel to traditional public transportation and taxi systems. These transportation modes, however, remain to be integrated with previously existing alternatives in any complementary manner. Various transportation modes vie for users across platforms, with the newer services often seeming to have advantages due to their ability to adapt quickly and meet immediate user needs. Nonetheless, the newer modes currently are unable to support the demands of 1.36 million passengers daily.

The newer services have resulted in a steady drop in the number of passengers using the public transit system. In 2008, public transit hosted 1.9 million riders, but by 2018 the level had dropped to 1.37 million. During the same period, the fleet of individual vehicles increased from 818 thousand to 1.01 million. Personal vehicles now represent a 45.8 percent share of the transportation mode distribution in Curitiba.

Given these rapid changes, Curitiba seeks to adopt new approaches to the current urban mobility scenario. Combining assets and resources, and making them sufficiently attractive to riders to prevent individual vehicle use, has benefits to municipal traffic congestion, energy efficiency, and reduced CO_2 emissions.

The existing model for public transit system concessions in Brazil shows several signs of being outdated, manifesting in a general feeling of dissatisfaction from users and operators. Curitiba has targeted 2025 as a time target for a new public transit system concession. The city desires to implement an innovative and bold approach, using a zero-emissions fleet, a combination of services, and the possibility of starting a smart grid network.

Potential sources of financing are ticket sales and accessory revenues. Curitiba will add public resources only if the system needs to be balanced.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project status and implementation timeline for each of the Vale do Pinhão projects is described below:

1. Public-Private Partnership for Street Lighting Modernization

Curitiba's public lighting PPP is currently being structured for a bidding process. BNDES (Brazilian National Development Bank) was hired, in January 2020, to develop the technical services related to the management, modernization, efficiency, expansion, operation, and infrastructure maintenance of the system. The Bank is also responsible for the entire bidding process and formalization of the contract.

Work will require 18 months to complete, with bidding expected to commence in the second half of 2021. The minimum duration for the concession is 20 years.

2. Concession of Mobility Services

Several technical cooperation agreements already have been agreed to propose a new urban mobility system for Curitiba and study design possibilities for the next concession's business model. Institutions currently working with City Hall are the Inter-American Development Bank (IDB), Deutsche Gesellschaft für International Zusammenarbeit (GIZ), the French Development Agency (AFD), the World Resource Institute (WRI Brasil), the Ministry of Regional Development (MDR), and the C40 Cities' Network.

Following the finalization of a system proposal, Curitiba will publish a bid for the concession in the second half of 2023, with the concession period beginning in 2025 for fifteen years.

PROJECT COST AND FINANCING

The Vale do Pinhão projects have an aggregate value of $3.4 billion, including two lengthy (15- and 20-year) concessions. Details concerning project cost and financing for the two concession projects include:

1. Public-Private Partnership for Street Lighting Modernization

BNDES (Brazilian National Development Bank) is developing technical services related to the management, modernization, efficiency, expansion, operation, and infrastructure maintenance of the Street Lighting Modernization system. The Bank is also responsible for managing the bidding process and formalization of the resulting contract.

The successful bidder operating the PPP will receive earnings from the “Contribuição do Serviço de Iluminação Pública” (COSIP), a fund aggregating all financial contributions to the operation of the public lighting system, including:

- Citizen payments via monthly energy bills
- Additional revenue streams, such as IoT application access, as described above

The system operation contract is estimated at $18.4 million (BRL 100 million) per annum, or $368 million over the envisioned 20-year concession.

2. Concession of Mobility Services

Estimated concession costs for the envisioned 15-year period will be US$ 2.8 billion.

U.S. EXPORT OPPORTUNITIES

A variety of Vale do Pinhão export opportunities exist for U.S. companies with respect to the concession projects (*Table 9*).

Table 9: U.S. Export Opportunities – Vale do Pinhão Concession Projects

Vale do Pinhão Concession Project	U.S. Export Opportunities
1. Public-Private Partnership for Street Lighting Modernization	• ICT hardware - smart poles, sensors • ICT software - IoT apps, control center • Participation in concession management
2. Concession of Mobility Services	• Advisory services – ride-hailing/-booking • Participation in concession management

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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BRAZIL'S NEW E-GOVERNMENT STRATEGY	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Brazil**
PROJECT VALUE	**Budget Not Yet Estimated**

PROJECT SUMMARY

- Brazil adopted its second national e-Government Strategy at the end of April 2020.
- The first e-Government Strategy, implemented from 2016 to 2019, achieved the digitization of about half of the country's federal processes.
- The second Strategy sets a target to offer digitally 100 percent of the more than 3,000 government services in the Federative Republic of Brazil.

PROJECT BACKGROUND AND DESCRIPTION

Brazil adopted a new national e-Government Strategy, through Decree 10,332, on April 28, 2020. The Strategy will guide the digital transformation of all federal agencies and entities, with the objectives of offering:

- Better quality services
- Simplified accessibility
- Reduced costs to citizens

The elaboration of the Strategy involved 150 participants from 32 organizations from both the public and private sectors. In addition, the Strategy considered more than 320 contributions received in a public consultation held in November 2019.

Brazil implemented its first e-Government Strategy during the period 2016 to 2019 (*Figure 22*). By 2019, 53 percent of the federal government services were available digitally. In 2019 alone, Brazil set a record by digitizing more than 500 public services across 28 different agencies.

Examples of successes from the first strategy include:

- Budgetary savings from implementing the e-Government strategy reaching 345 million reais in 2019;
- Yearly savings of 146 million hours citizens previously spent commuting, waiting, and handling administrative affairs; and

- Introduction of a digital work card from the Ministry of Economy, reducing issuance time from typically 17 days for the physical version to same-day service for the digital version.

Figure 22: Brazil e-Government Rapid Transition to Electronic Voting

Despite these advances, the new e-Government Strategy addresses closing an important, remaining gap; Brazil has the fourth largest, digitally connected population in the world, but ranks only 44th in terms of digital governments, according to the United Nations (UN).

By the end of 2022, Brazil plans to offer digitally 100 percent of the more than 3,000 services throughout the country. All will be available on the www.gov.br portal. By achieving this target, Brazil aims to be one of the 15 most developed countries in the world in terms of digital public services, as measured biennially by the UN as part of its Electronic Government Development Index.

Six guiding principles organize the Strategy:

I. Citizen-Centered
II. Integration
III. Intelligence
IV. Reliability
V. Transparency
VI. Efficiency

Each principle overarches three concrete objectives, for a total of eighteen. In turn, each of the eighteen objectives inspires two to seven specific initiatives:

I. **CITIZEN-CENTERED: A citizen-centered Government, which seeks to offer a more pleasant journey and responds to your expectations through high-quality services.**

1) Provision of digital public services
    i. Transform all stages and digitize public services by 2022.
    ii. Simplify and streamline the opening, alteration, and extinction of companies in Brazil to allow procedures to be completed in one day.
2) Evaluation of satisfaction in digital services – by 2022:
    i. Offer a standardized means of assessing public satisfaction with at least 50 percent.
    ii. Improve the satisfaction of users of public services and obtain an average level of at least 4.5 on a scale of 5 points.
    iii. Improve the perception of the usefulness of the services' information on the single www.gov.br.
    iv. portal and achieve at least 75 percent positive user evaluations.
3) Create simple and intuitive digital channels and services
    i. By 2020, establish a minimum quality standard for digital public services.
    ii. By 2022, conduct at least 100 experience surveys with real users of public services.

II. **INTEGRATED: An integrated Government, which results in a consistent service experience for the citizen and integrates data and services from the Union, the States, the Federal District, and Municipalities, reducing costs, expanding the offer of digital services, and removing the burden of displacement from the citizen and presentation of documents.**

1) Single digital access to public services
    i. By 2020, consolidate 1,500 federal government domains onto the single www.gov.br portal.
    ii. By 2022, integrate all States to the gov.br network.
    iii. By 2020, consolidate the offer of mobile applications into a single federal government account in stores. Heretofore, different ministries created individual accounts in mobile app stores.
    iv. By 2022, expand the use of the single gov.br access to 1,000 digital public services.
2) Shared platforms and tools
    i. By 2022, implement digital payment methods for at least 30 percent of digital public services.
    ii. Provide a citizens' digital mailbox platform.
3) Integrated public services
    i. By 2022, interoperate the systems of the Federal Government, so at least 900 public services have automatic information filing.
    ii. By 2022, increase the number of attributes in the citizen's base register to 20.
    iii. By 2022, establish 15 base reference registers for interoperability by the Federal Government.
    iv. By 2020, establish an interoperability bus for Federal Government systems to ensure people, organizations, and computer systems may share data.

III. **INTELLIGENT: An intelligent government, which implements effective policies based on data and evidence and proactively anticipates and solves the needs of citizens and organizations, in addition to promoting a competitive and attractive investment environment.**

1) Public policies based on data and evidence
    i. By 2022, produce 40 new public policy evaluation/monitoring panels.
    ii. By 2022, catalog at least the 300 main databases of the Federal Government.
    iii. By 2020, make available the map of companies in Brazil.
2) Public services of the future and emerging technologies
    i. By 2022, develop at least six research, development and innovation projects with partners from the Federal Government, higher education institutions, the private sector, and the third sector.
    ii. By 2022, implement artificial intelligence resources in at least twelve federal public services.
    iii. By 2022, make at least nine data sets available through blockchain solutions in federal public administration.
    iv. Implement resources to create an interoperable Federal Government blockchain network using reliable identification and secure algorithms.
    v. Implement a data experimentation laboratory with emerging technologies.
3) Predictive and personalized services to the citizen
    i. By 2022, implement a mechanism to personalize the offer of digital public services based on the user's profile.
    ii. Extend notification to citizens, by at least 25 percent, of digital services.

IV. **RELIABLE: A reliable Government, which respects the freedom and privacy of its citizens and ensures an adequate response to the risks, threats, and challenges that arise with the use of digital technologies in the State.**

1) Implementation of the General Data Protection Law within the scope of the Federal Government
    i. By 2020, establish a method of adaptation and compliance of bodies with the requirements of the General Data Protection Law.
    ii. By 2020, establish a platform that manages privacy and use of citizens' personal data.
2) Ensuring the security of digital government and mission-critical platforms
    i. Ensure at least 99 percent availability of shared digital government platforms by 2022.
    ii. Monitor at least 80 percent of cybersecurity risks on shared digital government platforms.
    iii. Define a minimum cybersecurity standard to be applied to digital channels and services.
3) Citizen digital identity
    i. By the end of 2020, provide two million monthly biometric validations for federal public services.
    ii. Make digital identity available to citizens, with an expected admission of 40 million, by 2022.

iii. By 2022, create the conditions for the expansion and reduction of the costs of digital certificates to a maximum cost of R$50.00 (fifty reais or just under $9) annually per user.
iv. Make new digital signature mechanisms available to citizens by 2022.
v. Encourage the use of digital signatures with a high level of security.
vi. Establish criteria for adopting an attribute certificate to simplify the qualification processes of an individual or entity.
vii. Promote the wide dissemination of systems and applications for use and verification of subscription policies with open and interoperable codes.

V. **TRANSPARENT: A transparent and open Government, which acts proactively in making data and information available and enables the monitoring and participation of society in the various stages of services and public policies.**

1) Reformulation of transparency and open data channels
   i. Integrate the transparency, open data, and ombudsman portals into the single gov.br portal by 2020.
   ii. By 2022, increase the number of open databases to reach 0.68 points in the criterion of data availability of the index published by the Organization for Economic Cooperation and Development.
   iii. Improve the quality of open databases to reach 0.69 points in the criterion of data accessibility of the index published by the Organization for Economic Cooperation and Development.
2) Citizen participation in the elaboration of public policies
   i. Sign partnerships for the construction of social control applications, through three datathons or hackathons, by 2022.
   ii. Improve the means of social participation and provide a new participation platform by 2021.
3) Government as a platform for new business
   i. Make at least 20 new interoperable services available to companies and organizations by 2022.
   ii. Establish partnerships with institutions representing the information technology, communication, and digital identification industry, with recognized, collaborative participation.

VI. **EFFICIENT: An efficient government, which trains its professionals in best practices, and makes rational use of the workforce, and intensively applies technological platforms and shared services in operational activities.**

1) Optimization of information technology infrastructures
   i. By 2022, make at least six centralized purchases of common information and communications technology goods and services.
   ii. By 2022, expand the sharing of new software solutions.
   iii. Offer at least four information and communications technology solutions through the marketplace by 2022.
   iv. Optimize the infrastructure of at least 30 federal government data centers by 2022.
   v. By 2022, migrate to the cloud services from at least 30 agencies.

vi. By 2022, negotiate corporate agreements with the government's largest suppliers of information and communications technology to result in a reduction of at least 20 percent of list prices.

2) Digital as a source of resources for essential public policies
   i. By 2020, improve the methodology for measuring resource savings with digital transformation.
   ii. By 2020, provide a panel with the total savings of resources earned with the digital transformation.
   iii. By 2021, establish the process of reinvesting the savings obtained from the digital transformation.
3) Government teams with digital skills
   i. Train at least 10,000 professionals from Federal Government teams in areas of knowledge essential for digital transformation.
   ii. By 2022, disseminate the principles of digital transformation through events and communications actions to reach at least 50,000 people.
   iii. By 2022, expand the workforce dedicated to digital transformation in the Federal Public Administration by 2,000 professionals.

Most of the 58 specific initiatives enumerated in the e-Government Strategy will create opportunities for suppliers of e-Government systems and solutions. Two of the initiatives are interrelated and represent a specific public-sector data center opportunity:

- VI.1.iv Optimize the infrastructure of at least 30 federal government data centers by 2022
- VI.1.v. Migrate to the cloud services from at least 30 agencies by 2022

These two initiatives are described more fully as the Public Sector IT Infrastructure Optimization Project within this resource guide.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Brazil published the Decree adopting the e-Government Strategy at the end of April 2020. Agencies and entities of the federal public administration are currently preparing their Digital Transformation Plans to implement the Strategy. The Digital Government Secretariat of the Ministry of Economy is defining standards and offering shared technologies and services to support the planning process. Nevertheless, the planning process is experiencing delays due to COVID-19. Implementation of the Strategy is planned through the end of 2022. Impacts of COVID-19 on the overall implementation timeframe are not known yet.

PROJECT COST AND FINANCING

The Digital Government Secretariat of the Ministry of Economy will coordinate the initiatives and approve the Digital Transformation Plans of the agencies and entities of the federal public administration. The Special Secretariat for Modernization of the State of the General Secretariat of the Presidency of the Republic will coordinate and monitor the execution of the Digital

Government Strategy. The Secretariat will prepare consolidated implementation budgets at a future date.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies include:

- Cloud services, both infrastructure and third-party;
- Server virtualization software and advisory services;
- Data center migration services;
- Critical systems software and advisory services;
- Security hardware, software, and advisory services;
- Power management hardware, software, and advisory services;
- Personnel training and qualification;
- Mobile apps; and
- Social media, public relations, and adoption metrics advisory services.

CONTACTS

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PUBLIC SECTOR IT INFRASTRUCTURE OPTIMIZATION	
SUBSECTOR	**e-Government** **Data Centers and Cloud Computing**
LOCATION	**Brazil**
PROJECT VALUE	**$5.5 Million**

PROJECT SUMMARY

- The objective of the Brazilian Public Sector Information Technology (IT) Infrastructure Optimization Project is to guarantee the availability of mission-critical IT systems and services.
- By 2022, the Project will optimize the infrastructure of at least 30 federal government data centers and migrate services from at least 30 agencies or entities to the cloud.
- After a 2019 questionnaire evaluating 117 agencies, operating 133 data centers, as well as an in-depth diagnosis of 75 agencies in 2020, the Project is presently preparing action plans for all affected agencies.

PROJECT BACKGROUND AND DESCRIPTION

In 2019, the Secretariat for Digital Government (SDG) of the Ministry of Economy prepared a self-diagnostic tool for public sector IT technology infrastructure. A total of 117 public agencies and entities completed the questionnaire. The survey identified 133 data centers under federal government management.

The findings of the survey identified common operational challenges, including:

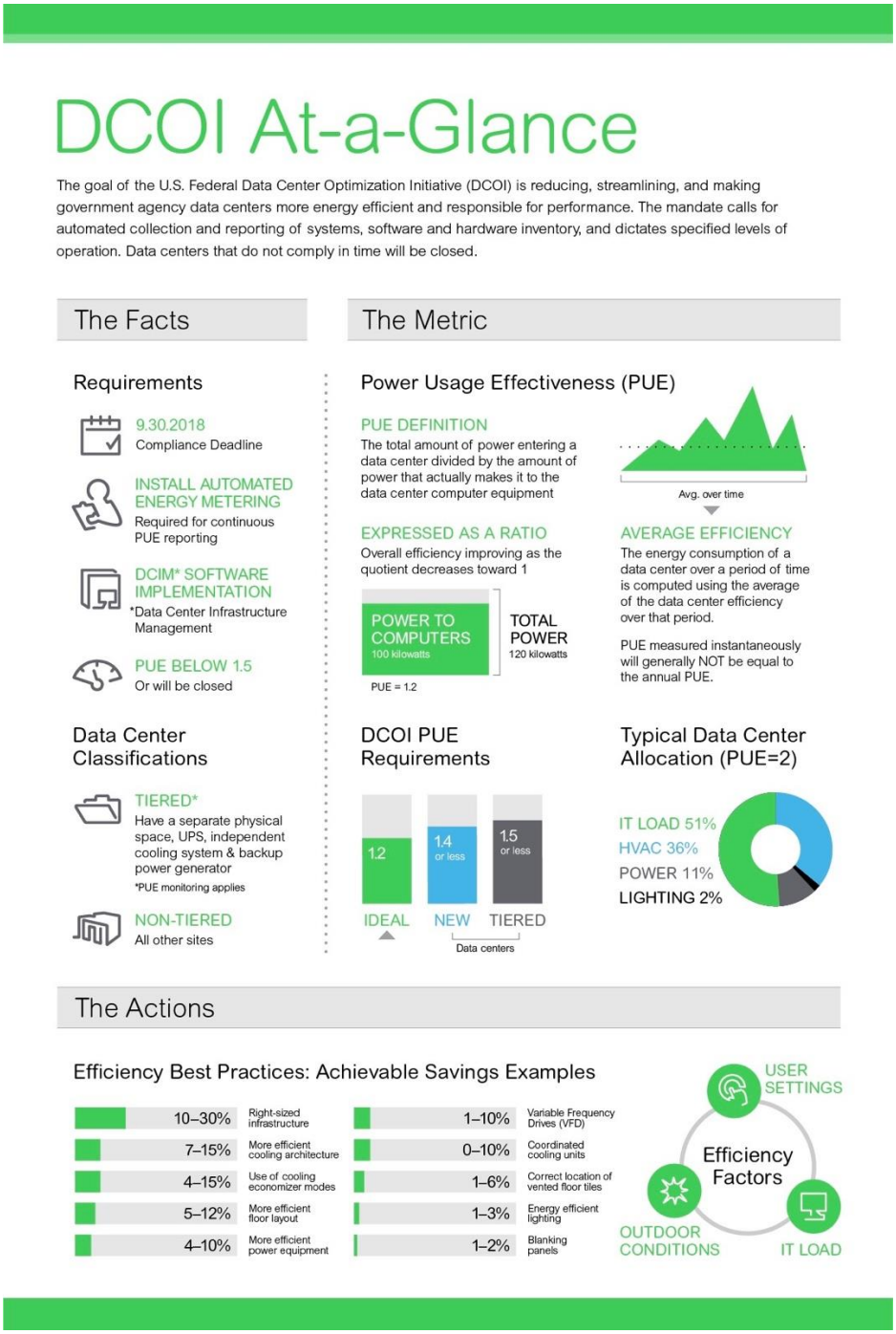
- Hardware and software without warranty coverage or maintenance contracts;
- Deficiencies in the physical installations hosting the data centers, including the reliability of power supply, environmental control, and security; and
- Lack of operational personnel.

Based on the survey results, the SDG next analyzed the importance of implementing improvements by consolidating and modernizing the federal government's IT infrastructure. The SDG proposed three potential priority activities:

1. Increasing the resilience and security of critical infrastructure and services;
2. Consolidating and optimizing local infrastructure; and
3. Increasing the adoption of cloud services.

The SDG also benchmarked similar project initiatives, including the Data Center Optimization Initiative (DCOI) project of the U.S. government (*Figure 23*).[31]

Figure 23: United States DCOI Benchmark Examples



[31] https://www.gsa.gov/technology/government-it-initiatives/data-center-optimization-initiative-dcoi

Based on the survey and the SDG's broader analysis, recommendations include action items and investment initiatives to overcome detected weaknesses. The recommendations also suggest reducing the number of data centers to optimize budget expenses and human resources for maintenance and operation. The recommendations form the basis for the Public Sector IT Infrastructure Optimization Project.

The IT Public Infrastructure Optimization Project fully aligns with Brazil's new e-Government Strategy, described elsewhere in this Resource Guide, and encompasses two of its initiatives to be completed by 2022:

- Initiative 16.4: Optimize the infrastructure of at least 30 government data centers.
- Initiative 16.5: Migrate services from at least 30 agencies to the cloud.

The overall objectives of the project are to:

- Guarantee the availability of mission-critical services and systems;
- Allow citizens access to essential public services;
- Supporting the provision of quality public services; and
- Minimize fiscal impacts.

The specific project objectives are to:

- Increase the availability of agency services;
- Modernize agency technological structure through the adoption of cloud infrastructure services;
- Assess and monitor the security of infrastructure and systems; and
- Guarantee the use and access to digital services and mission-critical systems.

The first phase of project implementation was initiated in 2020 by carrying out a new diagnosis of 75 public agencies and entities. The diagnosis is mapping these agencies' existing situations and future targets based on six key indicators (*Table 10*).

Six key indicators group into three different objectives:

- Adopt Cloud-based services;
- Improve infrastructure resilience and security; and
- Optimization of local infrastructure.

The ongoing diagnosis uses these indicators to profile the existing situation and establish short-term objectives to be achieved under the Program.

The SDG has established several partnerships for implementing the Project, including:

- The Centralized Purchasing Agency, from the Secretariat of Management of the Ministry of Economy, and
- Public information technology companies.

A team within SDG coordinates the Project, and includes a project manager, contract manager, and technical specialists with ICT infrastructure and cloud computing expertise.

Table 10: Public Infrastructure Optimization Objectives and Indicators

Objective	Indicator	Metric/Formula	Long-Term Target
CLOUD	Composite index of maturity for cloud		100%
Adopt cloud-based services	Cloud-based servers	# of cloud-based servers/total # of real and virtual servers	≥70%
SECURITY	Composite index of physical security		100%
Improve infrastructure resilience and security	Data center availability	Unavailable hours/total hours in the same period	100%
OPTIMIZATION	PUE – Power usage effectiveness	Total energy consumption/ energy consumption of IT equipment	≤1.5
Optimize local infrastructure	Use of virtual servers	# of virtual servers/total # of real and virtual servers	≥99%

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In 2020, the SDG has carried out a new diagnosis of 75 public agencies and entities. Remaining milestones for 2020 include:

- Quantification of the composite IT index for each agency and entity;
- Identification of technology solutions with agencies, partners, and public companies, including the planning for shared purchases; and
- Preparation of action plans for each agency and entity contemplating the fragility of operating environments, hosting of mission-critical systems, costs involved, estimated time, and management and operational staff availability.

The action plans will be implemented in 2021. The SDG will monitor and evaluate both implementation and its results. The effects of COVID-19 have delayed implementation of the Project during 2020.

PROJECT COST AND FINANCING

The initial project budget contemplates indicative actions during 2020 and 2021 of BRL 21.7 million, or approximately $5.5 million. The budget estimates cost categories include:

- Cloud services – both infrastructure and third-party services;
- Server virtualization software to optimize data center environments;

- Migration services to provide alternative solutions for agencies with high-risk datacenters; and
- Software and services to monitor critical systems, data center environments, and security.

This budget is estimated and may be changed according to the action plans for each agency and entity.

The SDG is exploring and evaluating national and international partnerships for implementation.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies under the Public Infrastructure Optimization program include:

- Cloud services, both infrastructure and third-party;
- Server virtualization software and advisory services;
- Data center migration services;
- Critical systems software and advisory services;
- Security hardware, software, and advisory services;
- Power management hardware, software and advisory services; and
- Mission-critical personnel training and qualification.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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JRT OASIS SMART CITY	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Brazil**
PROJECT VALUE	**$10 Million (Total for First 100 Oases)**

PROJECT SUMMARY

- With the advent of the deployment of Fifth Generation (5G) cellular network technology in Brazil, the country's larger cities face antennae and equipment installation challenges in high-density areas.
- This project provides for deploying Fourth Generation (4G)/5G infrastructure, both above and below ground, in strategic, high-demand, and high-value areas, in cities including São Paulo, Rio de Janeiro, Belo Horizonte, Salvador, Recife, and Fortaleza.
- The project sponsor, JR Telecommunicações (JRT), is a Brazilian supplier of telecommunications components and services.

PROJECT BACKGROUND AND DESCRIPTION

Brazil is about to deploy a 5G telecommunications network nationwide. While the deployment will improve network speeds and capacity, as well as reduce network latency, major urban areas face installation challenges. High-density areas may pose any or all of the following complexities:

- Space/real estate constraints;
- Need to avoid or uniquely navigate historical sites;
- Detailed local legislation;
- Strict environmental requirements; and/or
- Citizen concerns regarding visual impact.

Since 2008, JR Telecommunicações has provided telecommunications services and components for the Brazilian telecommunications industry. Via its United States subsidiary, JRT Business Group, LLC, the company has gained experience in deploying 5G network technologies and securing related technology-focused business partnerships.

The JRT Oasis Smart City project seeks to create 100 Oasis Smart City hubs across Brazil, focusing on high population density, cosmopolitan, Brazilian cities including:

- São Paulo (São Paulo);
- Rio de Janeiro (Rio de Janeiro);

- Belo Horizonte (Minas Gerais);
- Vitória (Espírito Santo);
- Florianópolis (Santa Catarina);
- Curitiba (Paraná);
- Brasilia (Distrito Federal);
- Salvador (Bahia);
- Recife (Pernambuco); and
- Fortaleza (Ceará).

Intended pilot projects for proof of concept and collection of performance data, include São Paulo, Brasilia, and Florianópolis.

One example of the type of location JRT is targeting, in late 2019, Architectural Digest named Rua do Bom Jesus in Recife the third most beautiful street in the world (*Figure 24*). The street is home to the first synagogue in the Americas, as well as numerous other buildings of historic value, with associated strict preservation regulations, and Porto Digital, a highly advanced technology hub, requiring high-speed internet access and 5G technology.

Figure 24: Rua do Bom Jesus in Recife

The JRT Oasis Smart City project includes:

- Deploying fully-owned 4G/5G network infrastructure for high-density areas;
- Targeting particularly high-density pockets in capital cities in Brazil;
- Using innovative, sustainable, and stealth technologies;
- Combining above- and below-ground routes;
- Delivering a secure, reliable, easy-to-maintain mobile network radio frequency signal in strategic high-demand and high-value areas; and

- Incorporating renewable technologies (e.g., organic photovoltaics to utilize solar energy to power network equipment).

JRT will offer its operational infrastructure sites to mobile carriers in Brazil. The carriers will pay a long-term rental fee for infrastructure access and use. Using a similar business model for the real estate industry, JRT also will offer open-space work areas with full access to state-of-the-art telecommunications technology.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Phase 1 of the JRT Oasis Smart City project is in the planning stage and includes negotiations with local authorities in relevant municipalities. JRT expects to complete design and planning for the JRT Oasis Smart City hubs by year-end 2020, with construction beginning in 2021 (*Table 11*).

Table 11: JRT Oasis Smart City Hubs Timeline – Phase 1[32]

	2020-2021											
month	01	02	03	04	05	06	07	08	09	10	11	12
ACTIVITIES FOR JRT OASIS PROJECT IN BRAZIL												
Concept Master Plan												
City Licensing												
Contract signing with clients												
civil Construction												
Installation												
Client Validation												
OPERATIONS START												

First construction projects are focused on high-needs areas of Brazilian state capitals, including Sao Paulo, Brasilia, and Florianópolis. JRT expects to complete construction for each hub within one year. During the first-year construction, JRT hopes to develop comprehensive data and results from its initial projects to fuel additional hubs. The overall project relies on scale economies for success, with an initial target of 100 Oasis Smart City Hubs.

PROJECT COST AND FINANCING

The cost of the initial Phase One projects will be approximately $10 million, with financing coming from a variety of sources, including private investment and public-private partnerships (PPPs). JRT anticipates 80 to 90 percent of the required investment will be sourced from private investors, with the balance from city governments requiring such participation.

[32] JRT Business Group

U.S. EXPORT OPPORTUNITIES

Export opportunities exist for U.S. firms offering smart cities solutions. Specific needs for the JRT Oasis Smart City hubs include:

- Antennae systems, hardware, and software;
- Small- and pico-cell technologies and equipment;
- Wireless telecommunications equipment;
- Batteries/battery storage solutions;
- Renewable ICT technologies including photovoltaics; and
- Advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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ANGRA DOS REIS SMART CITY PPP	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Brazil**
PROJECT VALUE	**$50+ Million**

PROJECT SUMMARY

- This project is a 25-year public-private partnership (PPP) under a concession agreement to implement, operate, and maintain a complete portfolio of smart city technologies in Angra dos Reis in southern Rio de Janeiro State.
- The PPP scope includes 33 smart city technologies addressing management, security, mobility, civil defense, tourism, public access, and the environment.

PROJECT BACKGROUND AND DESCRIPTION

Angra dos Reis is located in the southern portion of Rio de Janeiro State, along the highway connecting the state's capital with Santos. With over 200 thousand residents, the city's main economic activities are port operations, fishing, and tourism. The municipality includes 365 islands, the largest of which is Ilha Grande.

Angra do Reis has an ambitious smart city vision:

> *To deploy comprehensive interconnected and interactive networks of fixed and mobile ultra-high definition cameras and other sensors with sufficient resolution to locate stolen vehicles, coordinate rescuers with live emergency scene data via augmented reality, execute quickly pop-up services, request democratic participation, and more.*

Angra is opting for a public-private partnership (PPP) vehicle as a means to implement its smart city objectives rapidly. The PPP timetable envisions a 5-year investment period followed by two ten-year implementation periods. The PPP vehicle contemplates the possibility of extending the time frame of up to 35 years.

The PPP scope includes 33 smart city technologies and systems, divided into four main areas:

- Management;
- Mobility;
- Security; and
- Civil defense, tourism, public access, and the environment.

An Integrated Multiservice Control Center (Centro Integrado de Controle Multiserviços or CIC) will manage the core of the smart city initiative. The CIC will oversee the control of all smart operations, 24 hours a day, seven days a week, supported by a team of professionals. The CIC's function is to optimize and enhance the analysis of the data received for more effective decision making. Supporting this function is the ability to liaise with other bodies in real-time when necessary, such as the Military Police, Fire Department, and Civil Defense. Data collected online will be converted into indicators and integrated into a video wall. The CIC will act as an intermediary in emergencies, providing quick support to the population and first response professionals.

Other key management features include:

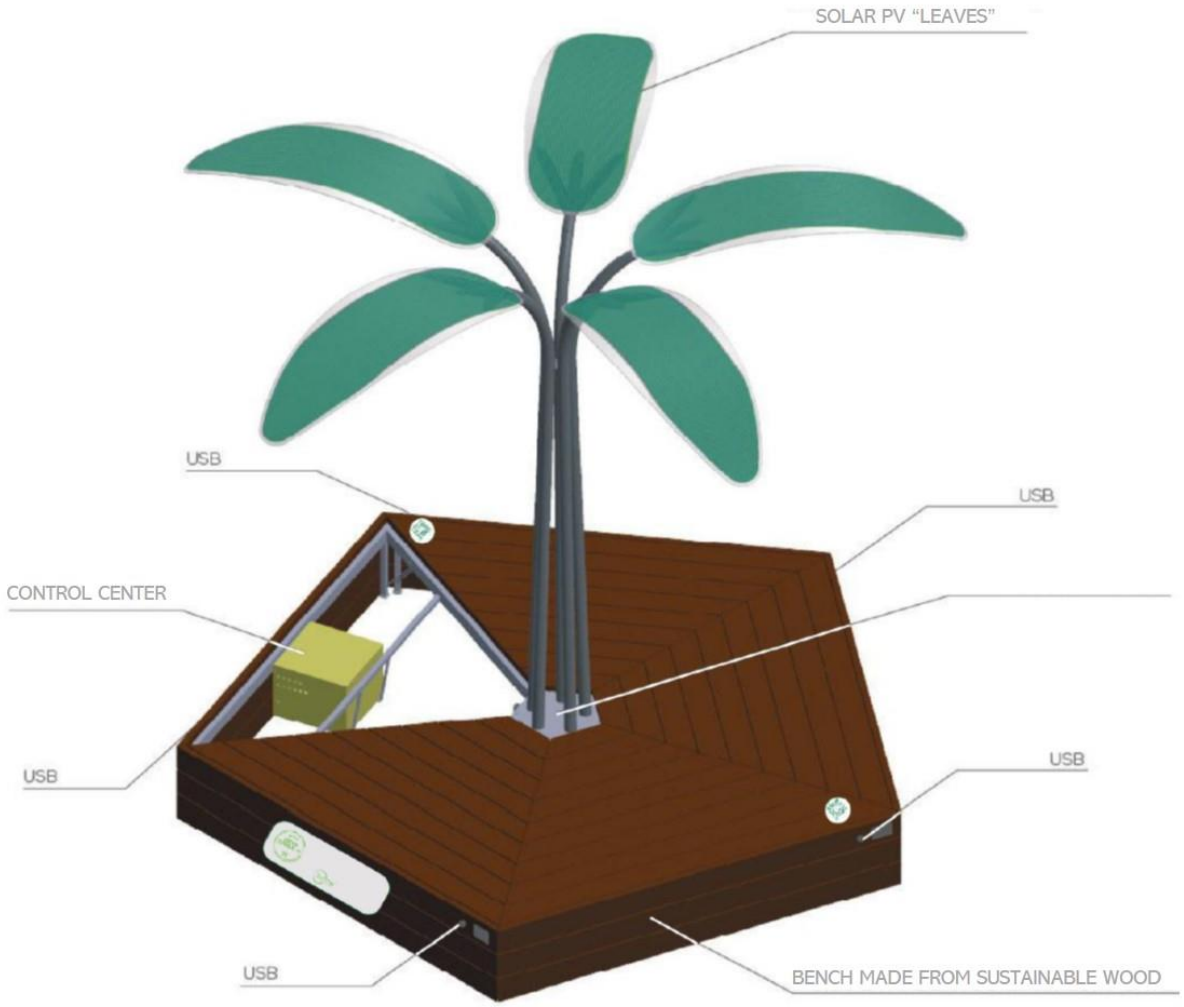
- An integrated call center for monitoring and controlling the flow of calls, thereby solving citizen issues as quickly as possible, as well as providing data for management and registration of calls and contacts made.
- Interfaces with municipal management software. These interfaces will incorporate legacy municipal systems including health, education, tax, administrative, social assistance, and the integrated geoprocessing/ geographical information system, Sistema Integrado de Informações Geográficas (SIGA).
- The software systems:
    - Unify the databases for performance management;
    - Utilize strategic data across the system;
    - Generate indicators for decision making; and
    - Aid in monitoring the sources of funds and public spending according to established goals.
- Interfaces with the Angra dos Reis Disaster Monitoring Center, which already exists. The Center collects data from rain gauges, soil sensors, event logs, and weather stations. The Center creates alerts, alarms, and city risk mapping.

The PPP concessionaire will be responsible for implementing numerous network enhancements for the municipality, including:

- Fiber optic links totaling approximately 120 km, from the Secretariat of Protection and Civil Defense (located in the São Bento District) to the Garatucaia, Serra D'agua, and Parque Mambucaba neighborhoods;
- Wireless point-to-point and multipoint or fiber-optic links to serve all of the city's municipal buildings and services, as well as a public WiFi system in 15 squares and public spaces;
- Structured cabling, including a voice over internet protocol (VoIP) system, for 260 municipal public buildings, including in urban and rural areas and on islands;
- Dedicated internet access and VoIP link to service public buildings, the city hall data server, and public squares;
- Logical network including routing, security, redundancy, high availability, and quality of service; and
- Management including availability, security, quality of service, and physical infrastructure.

A key requirement of the PPP is to provide free public WiFi access in 15 plazas throughout the city. The concession specifies accomplishing this using solar photovoltaic (PV) WiFi "trees" (*Figure 25*).

Figure 25: Rendering of a Solar PV WiFi "Tree" for Public Squares



Additional technological features of the smart city strategy include:

- Closed television circuits covering 260 public buildings;
- Urban monitoring system with fixed and mobile cameras connected to the network by the municipality. The monitoring system is to include cameras for reading license plates at strategic points, with a behavioral intelligence system and integration with the databases of various public security agencies;
- Integration of network and location services with municipal management systems;

- Optical character recognition cameras for vehicle surveillance. These will be installed in a belt around the city for access control and combined with pavement sensors for high-speed, dynamic weight assessment and speed detection;
- Traffic light automation with central control; and
- Automatic incident detection system, comprised of conventional network IP cameras providing high image quality and embedded processing.

The PPP concessionaire will have three income streams:

- Fees from operating a parking garage, calculated according to a published tariff methodology;
- Monthly remuneration from the municipality for providing fiber-optic network access; and
- Advertisement placement fees from smart billboards.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project was submitted for public comment in July 2020 and was expected to close on August 23, 2020. The government held an online public meeting on August 20, 2020.

The tendering process for the PPP is scheduled to commence in November 2020. Key milestones foreseen in this process include:

- Publication of the tendering process;
- Submission of requests for clarification;
- Publication of responses to requests for clarification;
- Deadline for rebutting tender documents; and
- Deadline for submitting tenders.

PROJECT COST AND FINANCING

Angra dos Reis has not published a budget or estimated value for this PPP. The annual budget for the city's first PPP, smart street lighting, is approximately $500,000. The scope of the smart city PPP is considerably larger than that for street lighting. Therefore, a value of at least $25 to $50 million over 25 years for this smart city PPP is likely.

The PPP concessionaire will be responsible for arranging implementation financing to cover the required capital expenditures.

U.S. EXPORT OPPORTUNITIES

The Angra do Reis PPP project offers several opportunities for U.S. companies, including:

- Fiber optic network hardware and spares;
- Network and location system hardware and software;
- Automated/smart traffic lights and control systems;
- Specialized digital cameras and associated networking hardware and software;
- Traffic control and monitoring sensors; and
- Advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
The municipality of Angra dos Reis has set up an email account for all PPP inquiries: angrappp@angra.rj.gov.br Prefeitura de Angra dos Reis Rio de Janeiro Brazil http://cidadeinteligente.angra.rj.gov.br/	Gabrielle Mandel Country Manager, Latin America, and the Caribbean LAC@ustda.gov Rodrigo Mota Country Representative, Brazil LAC@ustda.gov www.ustda.gov	Patricia Marega Commercial Specialist – IT, Telecom and Cybersecurity patricia.marega@trade.gov www.trade.gov

BRIDGING AMAPÁ'S DIGITAL GAP	
SUBSECTOR	**Smart Cities and e-Government** **Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Brazil**
PROJECT VALUE	**>$5 Million**

PROJECT SUMMARY

- The State of Amapá, Brazil has a dual Digital Gap:
  - Households have limited access to broadband internet services due to the State's remote location; and
  - The State's low population density hinders access to government services.
- This project seeks to bridge the Digital Gap by increasing broadband connectivity across Amapá and implementing an e-Government initiative – *Amapá in the palm of your hand.*

PROJECT BACKGROUND AND DESCRIPTION

Amapá is Brazil's northernmost coastal state, located north of the Amazon River (*Figure 26*). Throughout its history, the State has had no infrastructure connections with the rest of Brazil across the vast river.

Figure 26: Location of Amapá State in Brazil

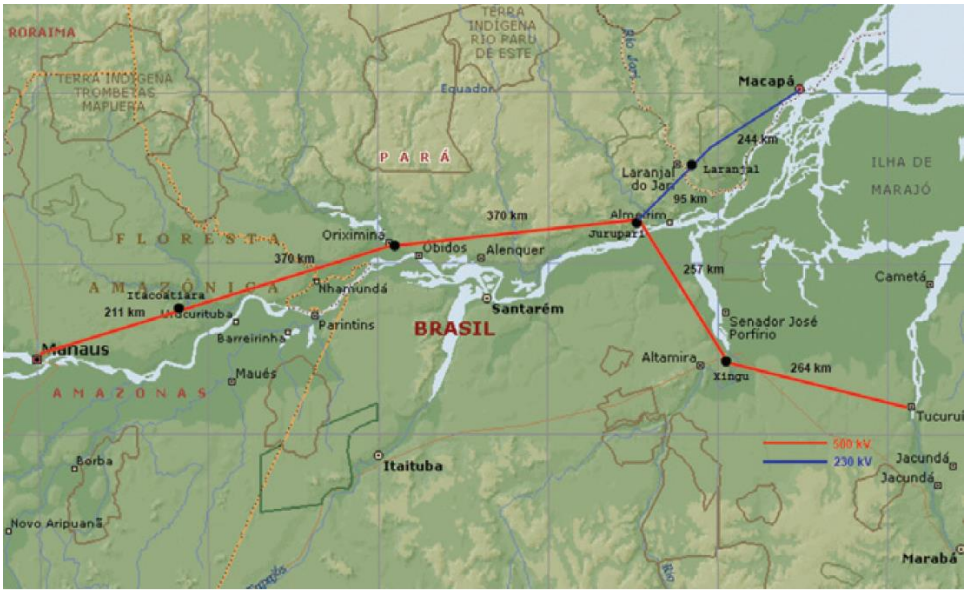
The State's population density is less than five habitants per square km, one of the lowest in the entire country. The State comprises 16 municipalities, with about 60 percent of the total population concentrated in the capital city of Macapá (*Table 12*).

Table 12: Amapá State Municipal Populations[33]

Municipality	2019 Population	Municipality	2019 Population
Macapá	512,902	Vitória do Jari	16,254
Santana	123,096	Calçoene	11,306
Laranjal do Jari	51,362	Amapá	9,187
Oiapoque	27,906	Ferreira Gomes	7,967
Porto Grande	22,452	Cutias	6,101
Mazagão	22,053	Itaubal	5,617
Tartarugalzinho	17,769	Serra do Navio	5,488
Pedra Branca do Amapari	17,067	Pracuúba	5,246

In 2013, Amapá's infrastructure connections with the rest of Brazil began with the Tucuruí-Macapá-Manaus (Electrical) Transmission Line. The line connects Brazil's second-largest hydroelectric plant, the 8,370MW Tucuruí Dam on the Tocantins River, with Macapá, the Amapá state capital, and Manaus, the capital of the State of Amazonas, (*Figure 27*).

Figure 27: Tucuruí-Macapá-Manaus Transmission Line



[33] Instituto Brasileiro de Geografia e Estatística

The transmission line crosses the Amazon River in a single span of 2.5 km. The 230kV segment through the southern border of the State of Amapá has substations in Laranjal do Jari and Macapá. TIM Brazil, the Brazilian subsidiary of Telecom Italia, installed multiple 100 gigabyte per second (Gbps) fiber-optic carriers along the line, bringing broadband connectivity to the States of Amapá, Pará, and Amazonas. Because of this transmission line, broadband internet service is now available in several Amapá municipalities, including Macapá, Santana, and Laranjal do Jari. It is not available, however, in more remote locations, such as Oiapoque, on the border with French Guiana, and Pracuúba, located in the center of the State.

The first project to bridge Amapá´s Digital Gap will evaluate and implement the most cost-effective route to increase broadband connectivity, considering both additions to the fiber optic backbone and the use of satellite connections. The initial feasibility study will provide specific infrastructure implementation details upon completion.

The second project to bridge the Digital Gap is an e-government platform known as *Amapá in the palm of your hand.* The platform is designed around three goals:

1. Integrate system and device sources to develop applications based on urban data from multiple and heterogeneous data sources;
2. Facilitate the development of applications from complex events in the domain of different sectors of Public Administration of the State of Amapá, including security, waste, urban mobility, tourism, health, and education; and
3. Change how the government interacts with citizens, companies, and other public-sector entities, through an architectural framework for e-Government.

Key features of the platform will include:

- A service-oriented architecture, acting as an application for mobile devices;
- Support for both Android and iOS mobile devices;
- Interfaces with the most diverse legacy systems of the Government of the State of Amapá, providing information and services to the population;
- Integration between applications through an enterprise service bus;
- Provision user-demand-based information regarding public-sector services:
- Unique registration of citizen data, using the telephone number originating any call, the associated name and Cadastro de Pessoas Físicas (the Brazilian taxpayer registry identification or CPF), *et al*
- Integration with online and real-time updating and registration processes; and
- Availability of service provision history to the public entity involved.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The feasibility study for the Amapá broadband connectivity expansion is in the initial planning phase. The study will develop further information regarding the project implementation timeline.

Centro de Gestão da Tecnologia da Informação (PRODAP), the public-sector IT company of the State of Amapá, is designing and preparing the system and architecture for *Amapá in the palm of your hand*. The first phase has an 18-month duration to demonstrate the platform and establish connections to Amapà's legacy systems. Future phases will develop applications.

PROJECT COST AND FINANCING

The feasibility study for Amapá's broadband connectivity expansion will estimate the budget and prepare a plan for obtaining implementation financing.

The budget for the initial phase to develop *Amapá in the palm of your hand* is nearly $1 million. Budget estimates for future phases are not yet available.

Project leadership anticipates an overall budget exceeding $5 million.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the Amapá Digital Gap project will include:

- Broadband network technology, hardware, and software;
- Legacy system integration technology and advisory services;
- e-Government application development and tailoring;
- Cybersecurity technology and advisory services; and
- Personnel and public training and development.

CONTACTS

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PROJECT ES DIGITAL	
SUBSECTOR	**Smart Cities and e-Government** **Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Brazil**
PROJECT VALUE	**$32 Million**

PROJECT SUMMARY

- The Brazilian State of Espírito Santo operates a fiber-optic network in the Greater Vitória metropolitan region connecting 560 state and local agencies.
- This project will expand the network to reach all municipalities across Espirito Santo, requiring nearly 5,000 km of new fiber optic cable and associated hardware to connect approximately 1,000 nodes.

PROJECT BACKGROUND AND DESCRIPTION

Instituto de Tecnologia da Informação e Comunicação do Espírito Santo (PRODEST) is the public sector IT specialist within the government of the State of Espírito Santo. Over several years, PRODEST has invested in a fiber-optic network connecting 330 state and local government agencies in the Greater Vitória metropolitan region. The network has demonstrated positive results in both speed and availability, as well as reducing State expenditures on third-party network access. An expansion project is currently underway to add 230 more nodes, bringing the operational total to about 560 communication links by the end of 2020.

The government's data center hosts many systems accessed over the network, including:

- Payroll of all public authorities;
- Control of judicial and administrative proceedings;
- Warehouse management, equity, bids, and contracts;
- State financial administration;
- Management of the state fleet of vehicles and license plates;
- Management of government programs and projects;
- Management of public schools;
- Management of public hospitals;
- Provision of the State system of georeferencing; and
- Others, including citizen services and tax collection.

The project objective is to expand the optical communications network in Greater Vitória to all municipalities in the interior of Espirito Santo. The fiber-optic network, "ES-Digital," will connect more than 700 state and local agencies.

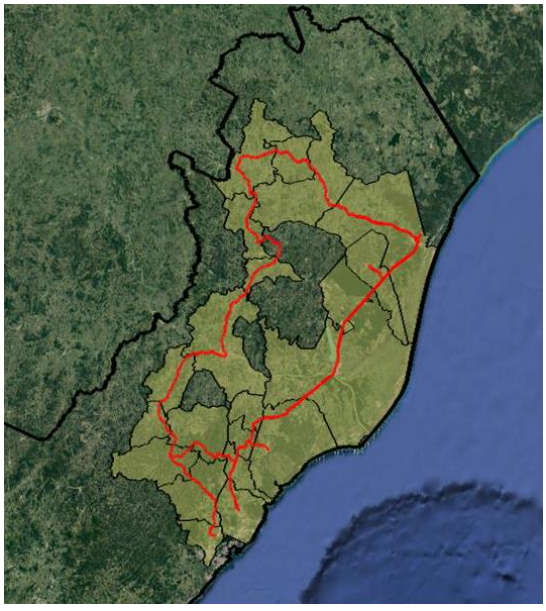
Project implementation will provide:

- Greater access to existing systems hosted in the government's data center;
- Convergence of ICT environments from different agencies to the data center;
- Ability to roll out new services via the internet for citizens;
- Ability to undertake new telecom and internet initiatives including video conferencing;
- Access to corporate (locally hosted) e-mail;
- Integrated telephony;
- Infrastructure redundancy for several departments (site backup); and
- Reduced public expenditure on access to third-party networks.

PRODEST has divided the project into two phases. Phase I (*Figure 28*) covers 20 municipalities in the northern region of the State. This phase will require approximately 1,200km of new fiber-optic cable and will contain 245 nodes. Phase I will cover the following municipalities:

Águia Branca	Aracruz	Barra de São Francisco
Colatina	Fundão	Ibiraçu
Itaguaçu	Itarana	Jaguré
João Neiva	Linhares	Nova Venécia
Santa Leopoldina	Santa Maria de Jetibá	Santa Teresa
São Domingos do Norte	São Gabriel da Palha	São Mateus
Sooretama	Vila Pavão	

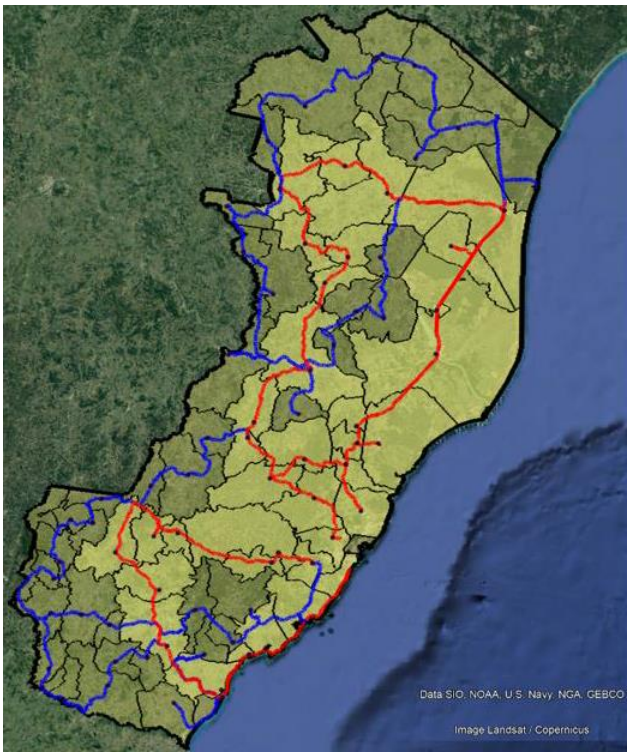
Figure 28: Phase 1 ES Digital Fiber-Optic Route Map *(in Red)*



Phase II (*Figure 29*) will cover the remaining 52 Espirito Santo municipalities. This phase will require approximately 3,500km of new fiber-optic cable and contain 686 nodes and cover:

Afonso Cláudio	Água Doce do Norte	Alegre
Alfredo Chaves	Alto Rio Novo	Anchieta
Apiacá	Atílio Vivácqua	Baixo Guandu
Boa Esperança	Bom Jesus do Norte	Brejetuba
Cachoeiro de Itapemirim	Castelo	Conceição da Barra
Conceição do Castelo	Divino de São Lourenço	Domingos Martins
Dores do Rio Preto	Ecoporanga	Governador Lindenberg
Guaçuí	Ibatiba	Ibitirama
Iconha	Irupi	Itapemirim
Iúna	Jerônimo Monteiro	Laranja da Terra
Mantenópolis	Marataízes	Marechal Floriano
Marilândia	Mimoso do Sul	Montanha
Mucurici	Muniz Freire	Muqui
Pancas	Pedro Canário	Pinheiros
Piúma	Ponto Belo	Presidente Kennedy
Rio Bananal	Rio Novo do Sul	São José do Calçado
São Roque do Canaã	Vargem Alta	Venda Nova do Imigrante
Vila Valério		

Figure 29: Phase 2 ES Digital Fiber-Optic Route Map *(in Blue)*



PROJECT STATUS AND IMPLEMENTATION TIMELINE

PRODEST has established the following timeline for project implementation:

2020	• Project design and feasibility study • Tender for Phase I (northern region)
2021	• Tender for Phase II (southern region and rest of State) • Initiate implementation Phase I
2022	• Finalize implementation Phase I • Initiate implementation Phase II
2023	• Finalize implementation Phase II

PROJECT COST AND FINANCING

PRODEST has estimated the following budget for project implementation by phases:

- Phase I - Northern Region: $12 million (BRL 54 million)
- Phase II – Southern Region and Rest of State: $20 million (BRL 92 million)
- Total: $32 million (BRL 146 million)

PRODEST is exploring alternative sources of financing for project implementation, including:

- Espírito Santo State Infrastructure Fund[34];
- Northeast Development Fund (FDNE[35]); and
- The Inter-American Development Bank.

Banco de Desenvolvimento do Espírito Santo (BANDES), the development bank for the State of Espírito Santo, is also exploring the possibility of structuring the project as a public-private partnership (PPP) by carrying out a market survey to detect potential interest.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies for ES Digital will include:

- Fiber optic network hardware and installation technology

[34] Fundo Estadual para o Financiamento de Obras e Infraestrutura Estratégica para o Desenvolvimento do Estado do Espírito Santo, recently established through Ordinary Law 11.002/2019

[35] Fundo de Desenvolvimento do Nordeste. This fund is managed by SUDENE, the Superintendency for Northeast Development, Ministry of Regional Development. Although the State of Espírito Santo is not part of Brazil's northeast region, the fund operates in 28 of the State's 78 municipalities.

- Internet-based e-government applications design, implementation, and support
- Video conferencing technology
- e-Mail integration technology
- Advisory services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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INFOVIA POTIGUAR	
SUBSECTOR	**Smart Cities and e-Government** **Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Brazil**
PROJECT VALUE	**$40 Million**

PROJECT SUMMARY

- Infovia Potiguar, a fiber-optic network, will connect about 100 municipalities across the Brazilian state of Rio Grande do Norte.
- Building on the existing RNP/CHESF network connecting education and research institutions throughout northeastern Brazil, the project comprises three phases.

PROJECT BACKGROUND AND DESCRIPTION

The Infovia Potiguar project aims to expand the high data-capacity and performance of the RNP/CHESF broadband network throughout the State of Rio Grande do Norte. The current network exists based on a Technical Cooperation agreement, signed in 2016, among:

- The Ministry of Education (Ministério de Educação, or MEC);
- The National Teaching and Research Network (Rede Nacional de Ensino e Pesquisa, or RNP); and
- The Hydroelectric Company of São Francisco (Companhia Hidrelétrica do São Francisco, or CHESF)

The agreement allowed the development and implementation of the network in the Northeast region. The initial phase of the RNP/CHESF network currently connects points of presence (PoP) in the following northeastern Brazilian states:

- Alagoas;
- Bahía;
- Ceará;
- Paraíba;
- Pernambuco;
- Rio Grande do Norte;
- Sergipe; and
- Piauí (through an expansion).

The existing RNP/CHESF network connects education and research institutions. Infovia Potiguar will expand the user base of the network to include:

- Free WiFi networks available in public places including squares, schools, hospitals, citizen centers; and
- Interconnection of state public agencies.

Infovia Potiguar strives to achieve digital inclusion within the State of Rio Grande do Norte, to encompass:

- Population access to information technology;
- Enhanced communications;
- Greater educational and professional qualification;
- Stimulation of trade via online shopping; and
- Facilitation of solutions to social difficulties.

The project sponsors also believe the project will provide economic development in the State, generating additional employment opportunities.

The project is structured in three phases. Phase One (*Figure 30*) aims to implement metropolitan networks in nine cities:

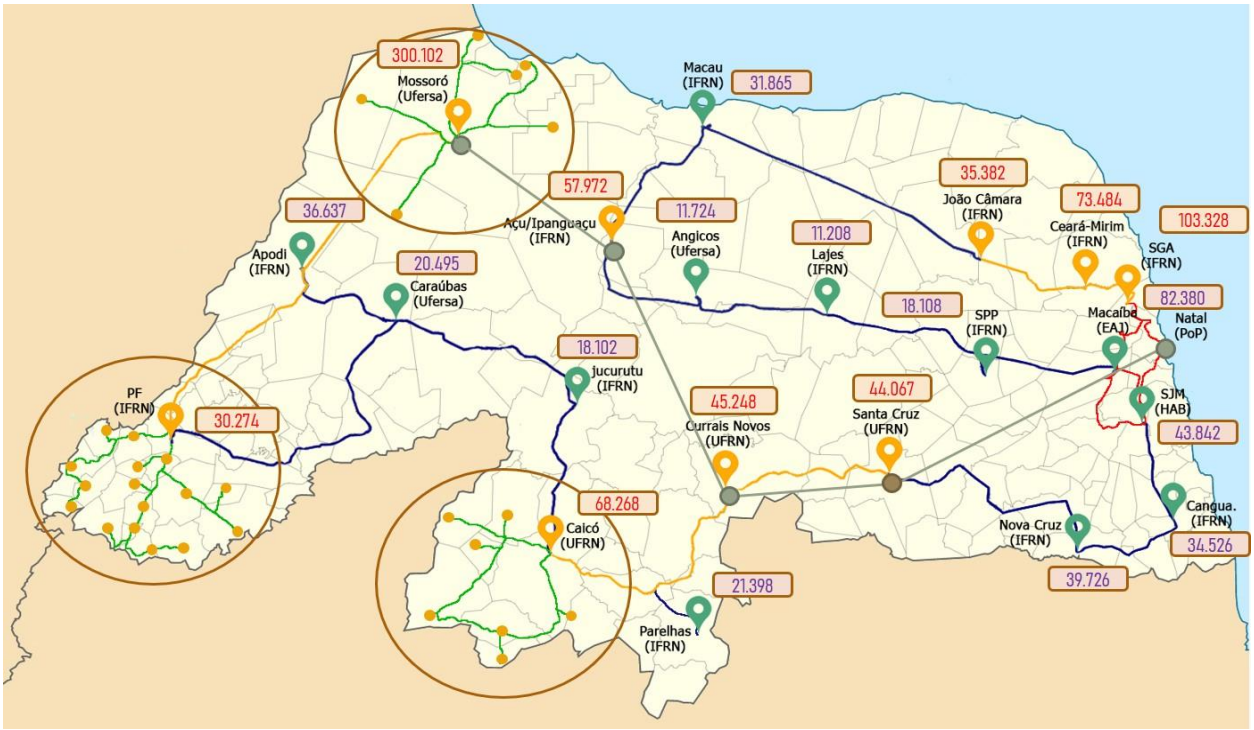
1. Currais Novos;
2. Santa Cruz;
3. Açu;
4. Ceará Mirim;
5. São Gonçalo do Amarante;
6. João Câmara;
7. Pau dos Ferros;
8. Mossoró; and
9. Caicó.

Phase One includes an upgrade to the network in Natal, known as GigaNatal. This phase also includes constructing a backbone to interconnect the various institutions of higher education and research, expanding the RNP / CHESF network in four specific locations: Açu, Currais Novos, Mossoró, and Natal.

Phase Two will build out the network to another 27 municipalities. Phase Three, the final phase, will add another 57 municipalities to the network. The planned, complete build out over the three phases spans Rio Grande do Norte *(Figure 31).*

Figure 30: Phase 1 Build Out for Infovia Potiguar

Figure 31: Complete Infovia Potiguar Build Out over 3 Phases



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project status and implementation timeline divide by phase:

Phase I: (9 Municipalities and GigaNatal)	• Implementation commenced in July 2020 • Target completion date – August 2021
Phase II: (27 Additional Municipalities)	• Preliminary studies complete • 3-year expected implementation timeline • Implementation to commence when funding is secured
Phase III: (57 Additional Municipalities)	• Preliminary studies are required • Implementation timeline to be determined during preliminary studies • Implementation to commence when funding is secured

PROJECT COST AND FINANCING

The Secretariat of State for Administration (Secretaria de Estado de Administração, or SEAD) is the designated lead agency for Infovía Potiguar. SEAD is managing and indicative budget for project implementation of approximately $40 million (BRL 200 million). This figure is subject to modification, informed by more detailed designs and studies.

SEAD has five partnerships for project implementation. In addition to RNP and CHESF, SEAD has established partnerships:

- Electric Company of Rio Grande do Norte (Companhia Energética do Rio Grande do Norte, or COSERN);
- Federal University of Rio Grande do Norte (Universidade Federal do Rio Grande do Norte, or UFRN);
- State University of Rio Grande do Norte (Universidade Estadual do Rio Grande do Norte, or UERN);

Collectively, SEAD expects the partners to provide a minority of the financing for project implementation. SEAD is exploring potential sources of implementation finance, including international financial institutions (IFIs) and Brazilian Federal Government entities, for the balance.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies for Infovia Potiguar include:

- Fiber optic network hardware and installation technology,
- e-Government applications design, implementation, and support,
- Education, training and professional certification applications design, implementation, and support,
- e-Retail and point-of-sale (POS) applications design, implementation, and support, and
- Advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SEMEAR AGTECH ROLLOUT	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Brazil**
PROJECT VALUE	**$15 Million (First 10 Sites, Rollout to >1,000)**

PROJECT SUMMARY

Centro de Pesquisa e Desenvolvimento em Telecomunicações (the Center for Research and Development in Telecommunications), originally the research and development arm of Telebras, and known as CPQD, is rolling out an integrated AgTech solution and business model known as SemeAr. The objective of SemeAr is to use digital technologies to provide productivity improvements for small and medium-size agricultural operations, achieving levels only available today to larger growers because of scale economies. The three pillars comprise SemeAr:

- Develop connectivity to provide wide coverage in remote areas, especially for small and medium-sized producers.
- Create innovative applications highlighting data analytics, artificial intelligence (AI), Internet of Things (IoT), and blockchain for automation of key farm/grower operational and management activities.
- Effect technological diffusion and mobilization, establishing agro-industrial districts, each served by a solution provider, also combining the actions of communication, dissemination, and mobilization of relevant entities.

PROJECT BACKGROUND AND DESCRIPTION

Agricultural land use in Brazil exceeds 2.8 million square km. The country is ranked fourth globally, behind China, the United States, and Australia. By comparison, agricultural land use in the entire European Union barely reaches 1.6 million square km.[36]

When segmented by the total number of establishments, most Brazilian farms are small (less than 200 hectares). When segmented by landholdings, however, medium (200 to 500 hectares) and large farms (greater than 500 hectares) account for the majority of Brazilian agricultural land (*Figure 32*).

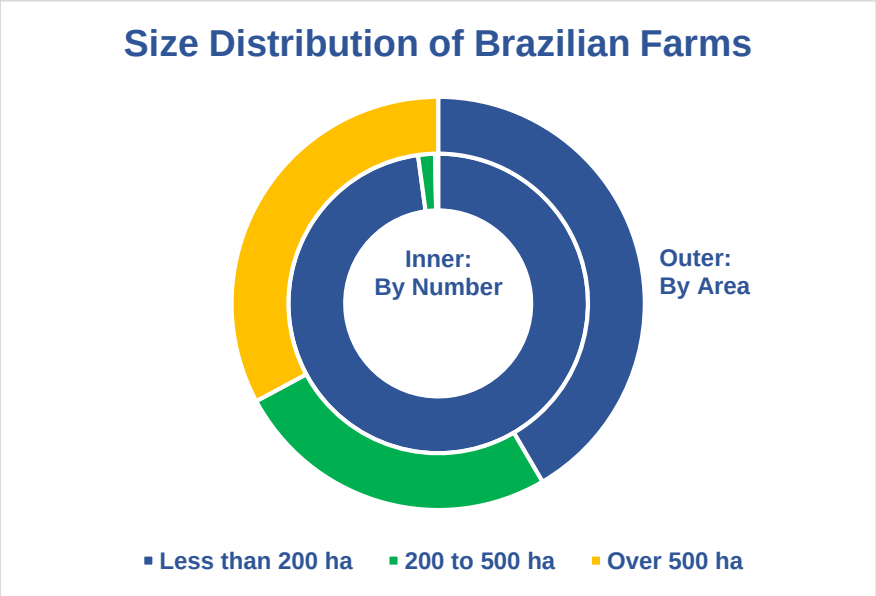
[36] Source: World Bank. World Development Indicators. Agricultural land (sq km). Data from 2016.

Only 0.3 percent of Brazilian farms are larger than 500 hectares. On the other hand, one-third of the country's farmland hosts farms larger than 500 hectares. When measured in terms of the value of production:

- The top 10 percent of all farms in Brazil account for 60 percent of the total value of production; whereas
- The trailing 56 percent of all farms in Brazil generate less than 15 percent of the total production value.[37]

Hence, larger farms currently enjoy scale economies challenging the competitiveness and viability of smaller holders.

Figure 32: Size Distribution of Brazilian Farms



Access to technology, including the ability to absorb technology, is a leading cause of the productivity disparity between larger agricultural operations and smaller to mid-size counterparts. According to a recent study[38]:

> *Most of the growth in production is attributed to the growth in technology, showing that it is possible to produce more with fewer resources. However, most producers have a low capacity for absorbing knowledge and therefore have not benefited from the technology's efficiency gains. In addition, these agents continue to have limited access to new technologies.*

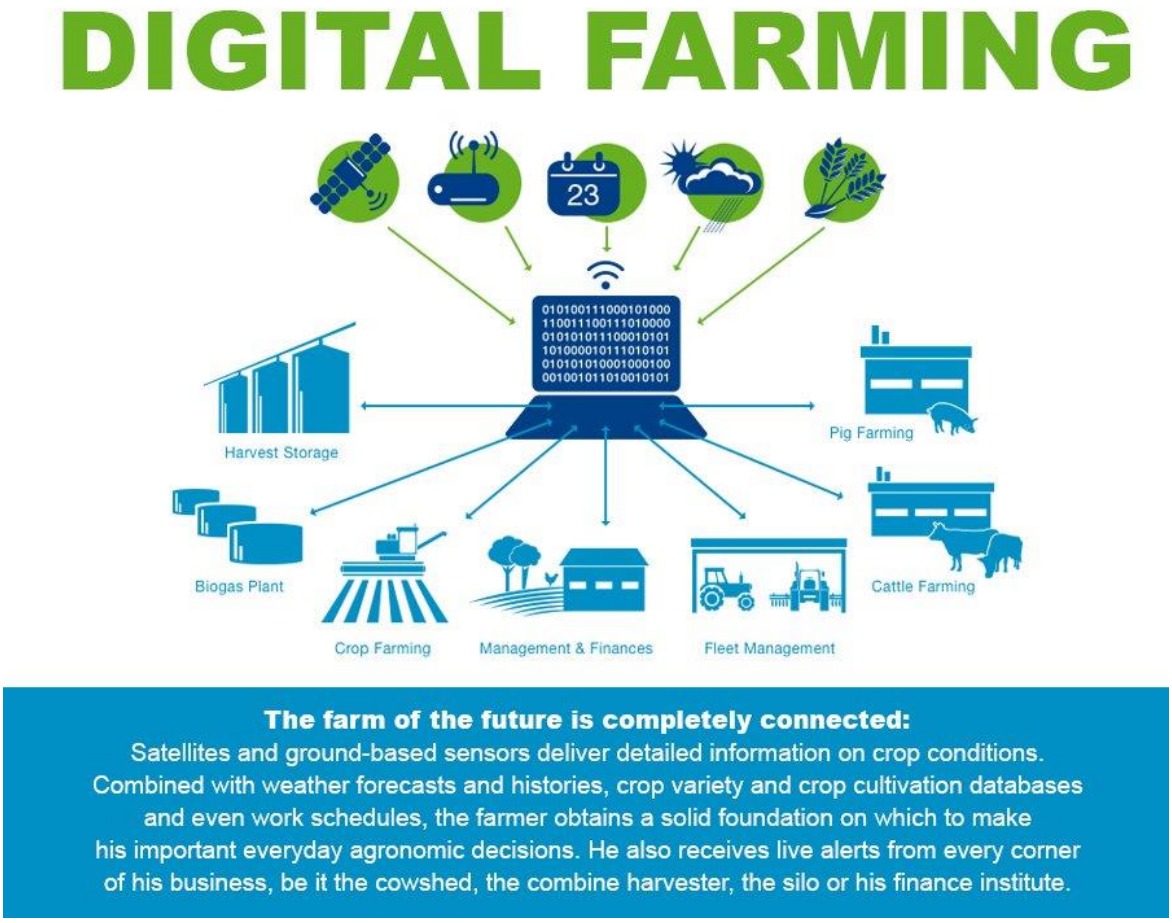
[37] Source IBGE Agricultural Census 2017, published in 2019
[38] IPEA, "Agricultura e Indústria no Brasil - Inovação e Competitividade," 2017.

The SemeAr initiative seeks to expand wealth creation for small- and medium-scale agricultural producers through application of digital technologies. SemeAr comprises a program of projects whose primary focus is to accelerate digital transformation for Brazilian agribusiness. Specific goals for SemeAr stress generating economic impact in terms of:

- Increased production volume;
- Improved product quality; and
- Enhanced production efficiency.

In essence, the SemeAr initiative will use digital technologies and solutions for small and medium-scale farmers to bridge today's gap of scale and scope economies yielding productivity advantages only to larger operations. Digital farming covers most agricultural and management processes (*Figure 33*).

Figure 33: Scope of Digital Farming[39]



[39] Bayer AG

Three main pillars organize the SemeAr Initiative projects:

1. **Connectivity** -- the development and validation of technologies and innovative operating models, service provision, and business, providing wide coverage in remote areas, especially for medium and small producers.
2. **Innovative Applications** -- the development of innovative technology use cases meeting priority demands and adding value to the business of producers. Cases will highlight data analytics, AI, IoT, and blockchain for:
    - Smart contracts;
    - Digital identity;
    - Traceability;
    - Financial services;
    - Marketplaces;
    - Shared economy;
    - Disintermediation;
    - Crop and animal management;
    - Property management;
    - Intelligent climate; and
    - Robotics, automation, sensors, and drones.
3. **Technological Diffusion and Mobilization** – further enhancing productivity by communicating, disseminating, and digitally mobilizing entities relevant to the agricultural value chain, including:
    - Cooperatives;
    - Producers;
    - Equipment and services suppliers;
    - Startups;
    - Entrepreneurship and innovation ecosystems; and
    - Public and financial agents.

SemeAr applications will focus on innovative use cases, seeking to solve real problems, meet priority demands, and add value to the business of producers, including:

- **Data Analytics, AI and Business Intelligence (BI)**: platforms and solutions for capturing, organizing, interpreting and using data, resulting in intelligence to foster improvements in efficiency and productivity;
- **e-Commerce and Marketplace/Shared Economy**: e-commerce solutions and marketplaces, as well as implementing the concept of a shared economy in a given area;
- **Farm-to-Table**: connecting production directly to the final consumer;
- **Animal Management**: platform and tools assisting in the management of animal breeding, including information integration and richer, real-time management vision to breeders;
- **Crop Management**: platform and tools assisting in the management of plantations and crops, including information integration and richer, real-time management views for producers;
- **Property Management**: platform and tools assisting in the management of property activities and routines, including information integration and provision of real-time management views;

- **New Forms of Planting / Intelligent Climate**: solutions and technologies creating new and improving existing planting techniques, as well as assisting in the monitoring and forecasting of climatic conditions;
- **Robotics and Automation**: solutions and hardware assisting in the automation of creations and plantations (e.g., vehicles or equipment) integrating with other devices for intelligent applications;
- **Sensors and IoT**: sensor technologies, trackers and other devices capturing information and monitoring creations, properties, and plantations;
- **Financial Services and Blockchain**: platforms and applications offering solutions related to financial operations and specifically using blockchain technologies to assist in digitizing processes in the field;
- **Traceability**: monitoring and asset tracking solutions for inputs and products generated in the field, including the capability to record history-of-origins and paths taken; and
- **Unmanned Aerial Vehicles (UAVs), Drones, and Geoprocessing**: solutions integrating the use of aerial navigation equipment (e.g., drones and UAVs) with intelligent image capture and processing.

The business model for implementing SemeAr uses the concept of an Agro-Technological District (DAT) as the basic operating unit. Each DAT comprises a specific geographic area and the associated community of rural producers. The DAT concept aims to generate, for the small and medium producer, economies of scale similar to larger producers, thereby reducing barriers and facilitating the adoption of digital technologies for the producer.

Crop diversity may exist in a DAT, recognizing the great diversity of morphoclimatic conditions in Brazil. However, in defining the region in which each DAT operates, an objective will be to maximize producer groups with similar crops to maximize economic synergies. The DATs are not yet defined, but CPQD speculates that the number could be on the order of a few thousand.

Each DAT will be supported and served by a single DAT provider, a local IT solution integrator, offering the entire range of SemeAr applications, as well as related training services, support, and maintenance. This structure aims to generate economies of scale and scope for small and medium producers similar to those enjoyed by larger producers.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Three phases will achieve SemeAr Initiative objectives:

- ***Phase 0*** -- development and validation of the first two DATs, serving clusters of small and medium rural producers.
- ***Phase 1*** -- a pilot test of eight DATs, integrating further applications in the toolkit, developing business models for DAT Providers, and planning for the wider roll-out.
- ***Phase 2*** -- commercial operation and expansion on a national scale, based on the previous phase reference models.

Phase 0 of the initiative is already underway. The first, experimental DAT is expected to be implemented in 2020 and operational during 2021. The ecosystem of partners and investors in the project includes Empresa Brasileira de Pesquisa Agropecuária (the Brazilian Agricultural Research Corporation, or EMBRAPA) and Ministério da Agricultura, Pecuária e Abastecimento (The Ministry of Agriculture, Livestock, and Supply, or MAPA) support. Phases 0 and 1 require a combined duration of 30 months.

PROJECT COST AND FINANCING

Private and public resources will finance SemeAr Initiative projects. CPQD is already arranging non-reimbursable resources for Phase 0.

CPQD estimates a budget of $15 million over 30 months for phases 0 and 1. This estimate assumes the development of ten DATs distributed across strategic regions in Brazil. The estimate may vary considerably depending on conditions in each location, the infrastructure required, and the range of services and applications to be offered.

The economic impact of the SemeAr Initiative on Brazilian agribusiness, assuming the satisfactory execution of Phases 0 and 1, is estimated at approximately $5 billion annually.

U.S. EXPORT OPPORTUNITIES

Numerous opportunities exist for U.S. exports under the SemeAr scope. These include:

- Software and apps
  - Data analytics
  - AI for agriculture
  - Weather applications
  - Agricultural GPS applications
  - Agronomy applications and soil analysis
  - Product quality and traceability applications
  - Land, crop, and animal management
- Network hardware, devices, software, and services
  - Connectivity hardware and cabling
  - Control and network management systems
  - Network management software and cybersecurity
  - Management, qualification, and training services
- Site hardware and devices
  - Sensors
  - IoT devices
  - IoT machinery, including land and aerial vehicles (drones, UAVs)
  - Robotic farm implements and systems
- Agricultural marketplace access and advisory services
- Blockchain software and services

- Other financial software and services
- Agricultural and agronomy software and services including soil and water testing
- Other agricultural automation advisory services

CONTACTS

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ARTIFICIAL INTELLIGENCE (AI) IN AGROENERGY	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Brazil**
PROJECT VALUE	**$2+ Million (Initial Seed Capital)**

PROJECT SUMMARY

- Itaipu Technological Park (Parque Tecnológico Itaipu or PTI) is proposing to create the Center for Artificial Intelligence in Agroenergy (Centro de Inteligência Artificial em Agroenergia or CIA-A).
- The CIA-A will generate high-impact AI solutions for the energy and agriculture markets, taking advantage of the entrepreneurship and innovation ecosystem at PTI.

PROJECT BACKGROUND AND DESCRIPTION

Itaipu Binacional created PTI to support its mission to foster local development. The PTI ecosystem of competencies and partner institutions includes companies, government agencies, teaching institutions, and science and technology institutions.

PTI's mission is to develop science, technology, innovation, and business, resulting in well-being and wealth for society. PTI currently concentrates its actions on four thematic areas:

- Agribusiness;
- Energy;
- Critical infrastructure security; and
- Tourism and cities.

PTI includes nearly 60 thousand square meters of laboratories, research centers, classrooms, and other spaces shared by students, teachers, entrepreneurs, and other professionals (*Figure 34*). The park is located in the area of the Itaipu Binacional plant in Foz do Iguaçu. The precise location was used previously for accommodations occupied by the construction workers who built the Itaipu hydroelectric plant in the 1970s and 80s.

In addition to other partner institutions, three universities share the site:

- The State University of Western Paraná (Universidade Estadual do Oeste do Paraná or Unioeste);

- The Federal University of Latin American Integration (Universidade Federal da Integração Latino Americana or Unila); and
- The Open University of Brazil (Universidade Aberta do Brasil or UAB).

Figure 34: Itaipu Technology Park

Within the park, the CIA-A will create high-impact AI solutions for the energy and agriculture markets. The Center aims to apply a unique management model, integrating PTI, Itaipu Binacional, Scientific and Technological Institutions (ICTs), and the private sector.

The application of AI will facilitate the optimization of agribusiness data collection and analysis. AI applications will include big data, data mining tools, and the development of smarter and more accurate algorithms to predict trends, harvests, and risks, thus increasing production efficiency.

The CIA-A will strive to achieve the following goals:

- Develop technological solutions in applied AI;
- Stimulate innovative entrepreneurship,
- Attract anchor companies; and
- Create new companies (i.e., startups).

The Center will have a strategic location, in the West of Paraná, near Itaipu Binacional. This region is also home to large agricultural cooperatives.

The technological capacity fostered by the CIA-A will provide conditions for ecosystem participants to develop specialized skills using two mechanisms:

1. Generation of new knowledge and capabilities for innovation through the technical training of professionals; and
2. Incentive to generate new technologies and technology-based ventures using the services and infrastructure of the CIA-A and PTI.

A separate but related project underway at PTI aims to promote innovative entrepreneurship in Foz do Iguaçu and the Western region of Paraná. This initiative is publishing notices to attract anchor companies, startups, and smaller companies, encouraging the development of new technologies and solutions. In the Spring of 2020, due to the COVID-19 pandemic, this project was reoriented.

This second project calls for proposals in the following areas:

- Corporate innovation;
- Desafio Inova Oeste – a regional innovation challenge;
- AI solutions for tourism, agro-energy, and energy; and
- Innovation projects, in partnership with other companies, startups or Scientific, Technological, and Innovation Institutions (ICTs).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The estimated duration of the CIA-A project is 36 months, divided into five phases:

- **Phase 1**: prepare a business plan, create a map of technological opportunities for action, and develop a governance model for the Center with SRI Valley and Sebrae Paraná.
- **Phase 2**: create the CIA-A, including developing both a technical team and the Center's physical and technological infrastructure.
- **Phase 3**: develop at least five AI technological solutions for real problems.
- **Phase 4**: promote educational actions enhancing the dissemination and generation of knowledge in AI.
- **Phase 5**: lever PTI's business incubator to create new startups. Seek partnerships with companies in the agribusiness and energy sectors.

The CIA-A project will start up in the third quarter of 2020.

The project to promote innovative entrepreneurship in Foz do Iguaçu and the Western region of Paraná has a duration of 30 months. The first public notice of the project, on Corporate Innovation, was launched in January 2020. The second notice was launched in July 2020. The third call for

proposals will be tendered in the first quarter of 2021. The upcoming call is aimed at promoting the generation of technological solutions in Artificial Intelligence by companies, for application in the tourism, agro-energy, and energy sectors.

PROJECT COST AND FINANCING

The CIA-A has an indicative budget of $1 million (BRL 5 million), which will be revised during Phase 1 business planning.

The project to promote innovative entrepreneurship in Foz do Iguaçu and the Western region of Paraná has a budget of $1.2 million (BRL 6 million). Itaipu Binational will provide 70 percent of this funding; PTI will finance the balance of the project.

PTI expects to leverage these seed capital investments with additional funds from domestic and international strategic partners and technology investors.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. companies include:

- Project seed capital and possible future-round equity investments;
- AI-related technology licensing;
- AI advisory services for the targeted tourism, agricultural and agro-energy sectors; and
- Project commercialization and technology transfer support.

CONTACTS

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AI TRENDS IN BANKING	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Brazil**
PROJECT VALUE	**>$1 Billion**

PROJECT SUMMARY

- The financial services sector accounts for 22 percent of all information and communications (ICT) expenditures in Brazil.
- In 2019, leading ICT technologies for the financial services sector were mobile applications, cloud computing, and data analytics.
- Future trends are unlikely to follow historical patterns. Instead, the financial sector will emphasize artificial intelligence, machine learning, and blockchain technologies.
- Numerous AI projects, by members of FEBRABAN, the Brazilian banking association, and ABFinTechs, the Brazilian Fintech association, will be available for investment.

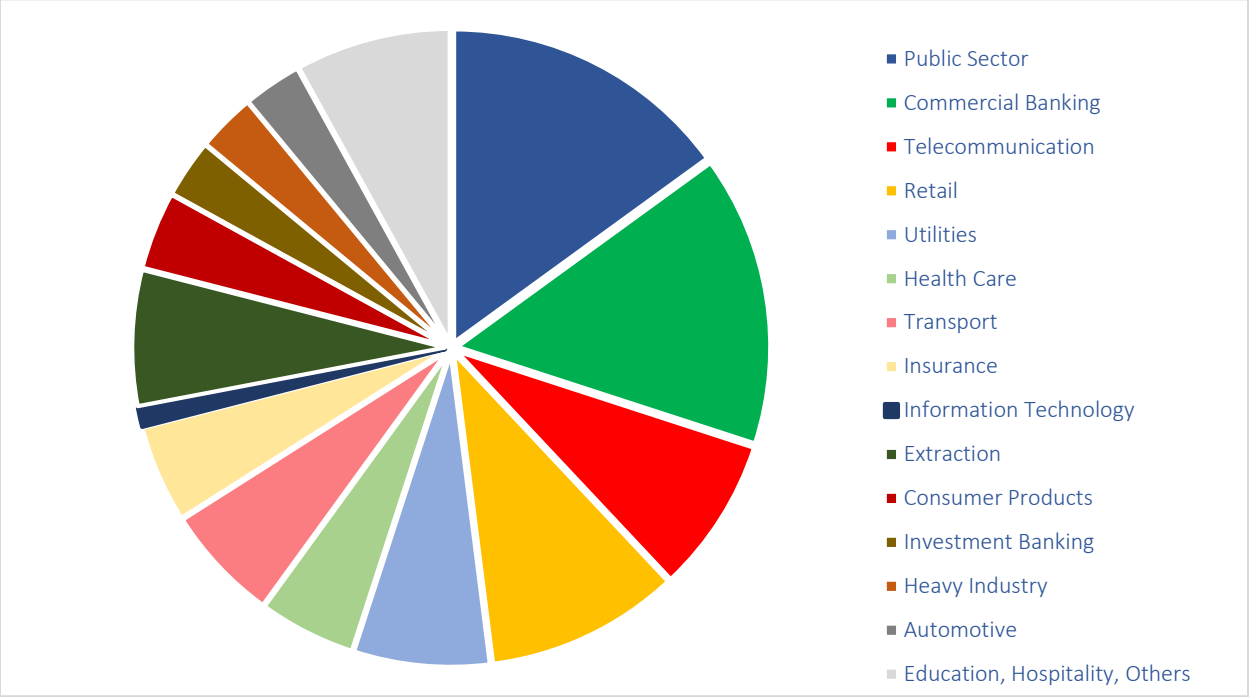
PROJECT BACKGROUND AND DESCRIPTION

Capital and operational ICT expenditures in Brazil reached $38.1 billion in 2019. While the public sector was the largest purchaser, it was followed closely by the commercial banking sector (*Figure 35*).

The financial services sector, including insurance and investment banking, was responsible for 22 percent of all Brazilian technology expenditures in 2019. Total 2019 ICT expenditures for commercial banking reached $4.6 billion (BRL 24.6 billion), having grown at an annual compound growth rate of over 6 percent since 2015. Relative investments in key ICT segments were:

- 53 percent in software acquisition, licensing, and development (up from 44 percent in 2015);
- 33 percent in hardware purchases and leasing (down from 36 percent in 2015); and
- 14 percent on telecommunication services and networks (up from 20 percent in 2015).

Figure 35: Brazil Technology Expenditure by Sector[40]



The key driver behind these ICT expenditures has been an increase in the number of banking transactions. The total number of transactions increased from 56 to 89 billion from 2015 to 2019, or at an annual growth rate of 13 percent. Two technologies have been responsible for the vast majority of this growth during the same period:

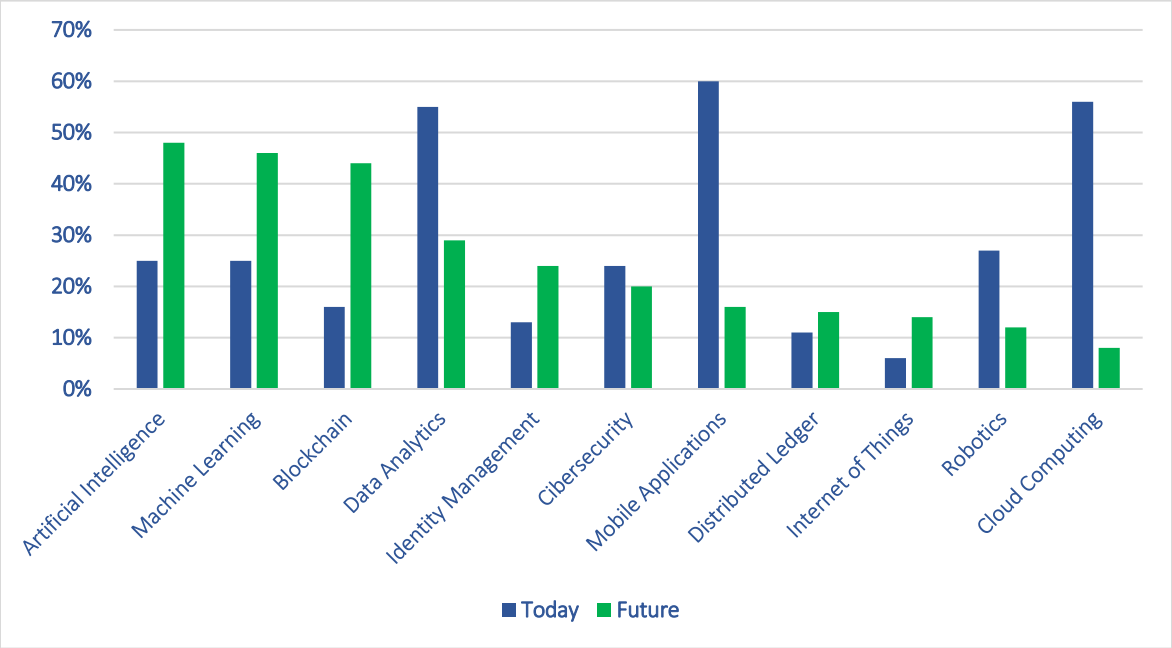
- Mobile banking (annual growth rate of 37 percent); and
- Point of sale solutions (PoS) (annual growth rate of 14 percent).

More mature technologies, such as internet banking and automated teller machines (ATMs), declined over the same period.

Technology innovations and disruptions will continue to affect the nature of ICT expenditures in the financial services sector (*Figure 36)*. Recently, Brazilian Fintechs have focused on mobile applications, data analytics, and cloud computing. Nonetheless, these technologies will decline considerably in relative significance in the next several years, being overtaken by artificial intelligence, machine learning, and blockchain technology investments.

[40] Deloitte Touche Tohmatsu based on data published by Gartner

Figure 36: Brazil Fintech Technology Focus Based on 2019 Survey of 205 Brazilian Fintechs[41]



The technology investment shift in the Fintech sector mirrors technology priorities reported by Brazilian commercial banks.[42] For sector participants:

- 72 percent expect to invest in AI projects;
- 35 percent in blockchain technology;
- 35 percent in robotic process automation for back-office operations; and
- 20 percent in the IoT.

Both surveys reinforce a strong trend toward the rapid adoption of AI applications. Leading AI applications include:

Chatbots:

- Improving customer experience is a key priority for many AI banking applications.
- Chatbots enabled with AI facilitate customer access to banking information and services.

Virtual Assistants:

- While chatbots generally focus on access to information and services, virtual assistants are more user-focused. Enabled with conversational AI, virtual assistants have expanded flexibility.
- Virtual assistants can also support back-office banking functions, including finance and human resources.

[41] Deep Dive 2019, a survey of Brazilian Fintechs carried out by PwC and the association ABFinTechs
[42] Interviews carried out by Deloitte Touche Tohmatsu

Robo-Advisors:	• Robo-advisors offer financial planning finely honed to customer needs. • Structured algorithms are being replaced by AI-powered machine learning in the next generation of robo-advisors.
Credit Evaluation:	• New AI applications for credit evaluation and pricing are streamlining banking processes and optimizing asset performance.
Biometrics:	• When combined with AI, biometric parameters are contributing to greater banking security and earlier detection of potential fraud.
Legal and Compliance:	• AI helps in interpreting standard document formats, such as contracts and notarized deeds, to facilitate compliance and reduce compliance costs.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Federação Brasileira de Bancos (FEBRABAN) represents 118 financial entities operating in Brazil. For AI projects, each entity defines its own project structuring and timelines.

Brazil is the largest hub of Fintechs in Latin America. Associação Brasileira de Fintechs (ABFinTechs), the Brazilian Fintech association, has mapped nearly 400 Fintechs in the country along 11 verticals, each of which will host AI opportunities:

1. Digital banks;
2. Exchange;
3. Exchange credits, financing, and debt negotiation;
4. Crowdfunding;
5. Financial efficiency;
6. Investment management;
7. Financial management;
8. Payment options;
9. Digital coins and blockchain;
10. Insurance; and
11. Others

PROJECT COST AND FINANCING

The Brazilian banking sector's total software expenditure was approximately $2.5 billion (BRL 13.2 billion) in 2019. Nearly two-thirds of these expenditures were classified as annual costs on

the banks' income statements (vs. being amortized). It is likely AI investments, similarly, will be primarily financed from operational cash flows.

Based on historical experience with more mature financial sector technology applications, the market for AI financial systems in Brazil is estimated to exceed $1 billion over the next five years.

U.S. EXPORT OPPORTUNITIES

AI application development and investment opportunities with FEBRABAN and ABFinTechs members include:

- Chatbot and virtual assistant applications and support
- Robo-advisor applications and support
- Credit assessment applications and support
- Legal and compliance applications and support
- Blockchain technology
- Biometrics technologies
- AI-based cybersecurity technologies
- Advisory services

CONTACTS

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YSSY ACQUE WATER NETWORK PILOT	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Brazil**
PROJECT VALUE	**$0.5 Million (for Pilot Demonstration)**

PROJECT SUMMARY

- Yssy Acque is a water network monitoring and control solution based on Industry 4.0 technologies. The solution includes wireless backhaul networking, IoT sensors, and a big data application using artificial intelligence and machine learning.
- A prototype has been operational in São Paulo since early 2020. This project is a full-scale pilot demonstration in Guarulhos, to be funded by the technology's developer, Yssy Soluções.

PROJECT BACKGROUND AND DESCRIPTION

Total losses in Brazilian water networks were 38.5 percent in 2018, according to the National Information System on Water Distribution (Sistema Nacional de Informações sobre Saneamento, or SNIS). These include both technical losses through the networks and commercial losses. Brazilian water losses, known as nonrevenue water (NRW), were 6.6 billion cubic meters in 2018. Global volumes of NRW are estimated to be 126 billion cubic meters per year, costing $39 billion annually[43].

With World Bank funding, the National Secretariat of Water Management of the Ministry of Cities recently carried out the COM + ÁGUA Project. The project's objectives were:

1. The integrated management of control/reduction of water losses; and
2. Ensuring energy efficiency for water utilities.

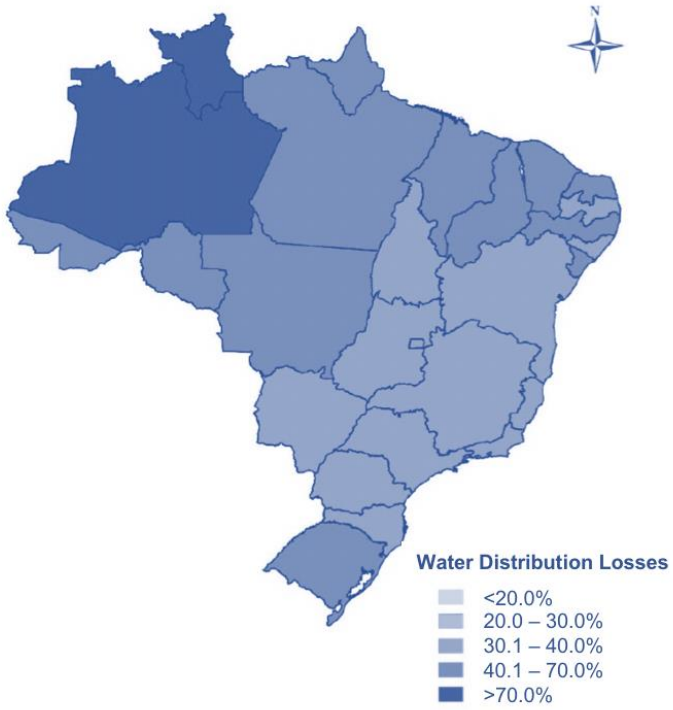
The COM + ÁGUA project demonstrated many benefits of water loss reduction, including:

- Reduced energy and chemical consumption via treating and pumping less water in the network;
- Reduced sewage treatment volumes from less leakage into the sewage network;
- Reduced environmental impact from less water required from source of origin; and
- Reduced risk of contaminating drinking water from a more robust network.

[43] MDPI - Monitoring Nonrevenue Water Performance in Intermittent Supply, June 2019

Water losses are highest in the North and Northeast regions of Brazil (*Figure 37).*

Figure 37: Water Losses in Brazil by State



The reduction of losses within water networks is often carried out by active leakage control (ALC) within district-metered areas (DMA). The International Water Association defines a DMA as a discrete area of a distribution system in metering of the quantities of water entering and leaving occurs. The flow of water is monitored to quantify the level of leakage in a DMA. Further monitoring and analysis can provide additional insight to support ALC, for example:

- *Hydraulic models* of the distribution system can establish reasonable targets for technical losses within each DMA; and
- *Empirical models*, coupled with flow and pressure monitoring within the network, can estimate the breakdown between technical and commercial losses within each DMA.

Thus, DMA management can determine more precisely where and when it is most beneficial to undertake loss location activities.

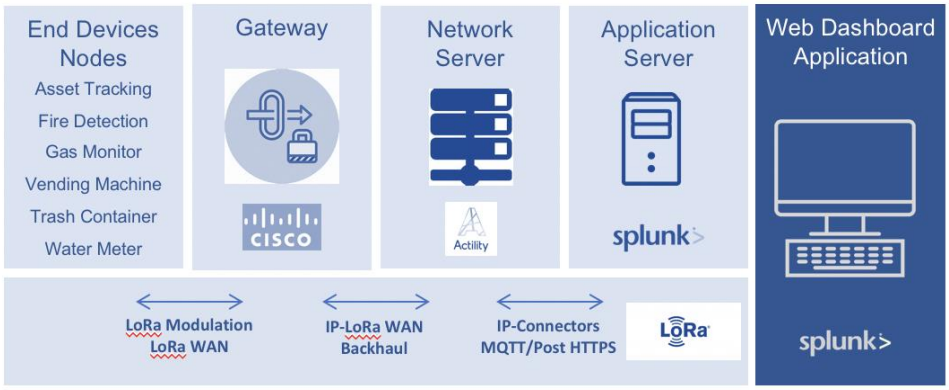
Yssy Soluções identified that Industry 4.0[44] technologies could provide monitoring and analysis capabilities for DMA management more cost-effectively than traditional, hardwired network

[44] The Fourth Industrial Revolution, i.e., the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology.

monitoring systems. Under a project entitled Yssy Acque, intended to test the concept, an initial prototype was operational and successful in early 2020. The project next enters a full-scale pilot demonstration.

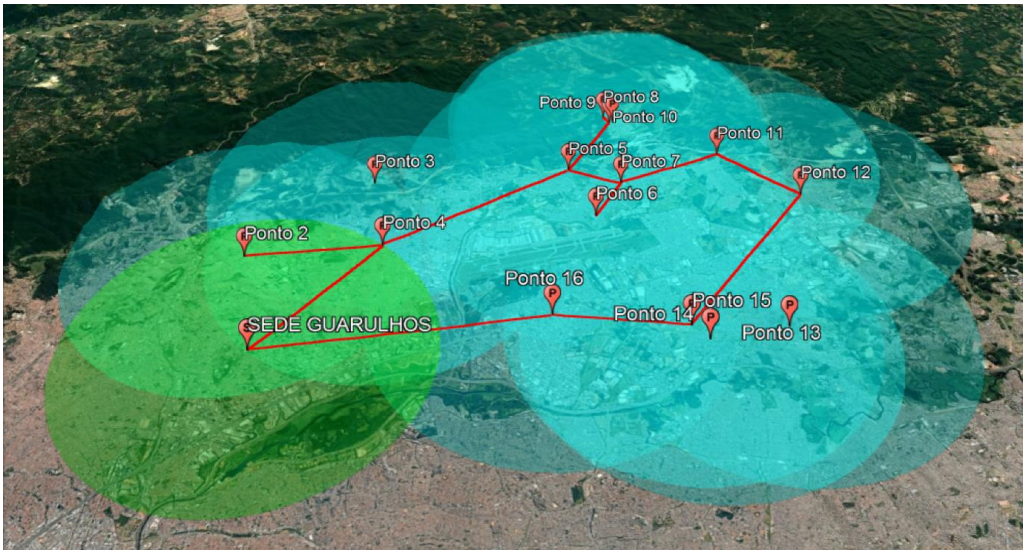
The Yssy Acque solution uses LoRa[45] wireless networks to connect end-device nodes to servers (*Figure 38*), using the Cisco Internet of Things control center.

Figure 38: Yssy Acque System Architecture



The project has identified the water network in Guarulhos, State of São Paulo (*Figure 39*), for the pilot demonstration.

Figure 39: Map of Yssy Acque Pilot in Guarulhos



[45] Short for long-range, LoRa is a spread spectrum modulation technique derived from chirp spread spectrum (CSS) technology.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Yssy installed a prototype system on a small segment of the water supply network in São Paulo in early 2020. The pilot system in Guarulhos will be operational in the first quarter of 2022. Key milestones for the larger pilot include:

- Implement the LoRa data network, ensuring a wireless signal at all points of the water supply network;
- Install transducers and modems capable of reading data from sensors (pressure, flow, and level) and activating devices (valves, pumps, and boosters) via LoRa modulation across the supply network;
- Develop/finalize the customized application portraying the current and historical status of the entire supply network's behavior. Ensure capabilities for diagnosing and correcting imbalances, as well as signaling and alerting possible non-conformities; and
- Integrate the new application with the legacy systems, allowing technology transition in the selected implementation DMAs.

PROJECT COST AND FINANCING

The cost of the pilot demonstration will be approximately $0.5 million, divided into roughly equal amounts for:

- Sensors and their modems;
- Data backhaul;
- Data center; and
- Solution and software.

Yssy Soluções is financing the entire cost of the pilot demonstration as part of its business development strategy. Potential sources of implementation finance will depend on the business model Yssy selects to roll-out the Acque project.

U.S. EXPORT OPPORTUNITIES

Yssy is a registered partner of several U.S. suppliers whose products are integrated into the Acque project, including:

- Cisco, with export potential for its IoT Control Center; and
- Splunk, with export potential for its big data applications based on AI and machine learning.

Additional opportunities for U.S. exports may exist for other Acque components, including:

- Sensors;
- Switches;
- Servers; and
- Cybersecurity.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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4 PARAGUAY

4.1 ICT Demographics

The majority of the Paraguayan population (7.2 million total) lives in the Eastern portion of the country, including the Paraguayan capital of Asunción (530,000 inhabitants), which is also the country's largest city. Requiring different approaches to ICT infrastructure, the Grand Chaco, a semi-arid lowland plain to the west, comprises 60 percent of landmass but only 2 percent of Paraguay's population. Paraguay is considered by the UN to have high human development.

Paraguay is landlocked, surrounded by Brazil to the north and east, Argentina to the south and west, and Bolivia to the northwest. Having no coastal access, the nation has been constrained in accessing high-volume, global, subsea communications infrastructure, although a plan is place, which is highlighted in this resource guide, to remedy this.

4.2 ICT Development

Paraguay's existing ICT sector, as measured by telephone, internet, and fixed broadband, meets world levels. Fixed broadband access has been particularly challenging, given the country's landlocked status. Paraguay is 94th and 95th in the world in terms of total fixed broadband and mobile cellular subscriptions, respectively, and, roughly similarly, 108th and 94th globally on a population-adjusted basis[46].

Under the auspices of the Ministerio de Tecnologías de la Información y Comunicación de Paraguay (MITIC), in conjunction with the Inter-American Development Bank, Paraguay has undertaken a Digital Agenda to enhance the country's ICT infrastructure. The Digital Agenda focuses on:

- **Institutional Strength**: improving the institutional framework and government capacity for developing the digital agenda.
- **Digital Government**: digitization of processes and improvement of services provided by the public sector.
- **Digital Economy**: extending broadband usage with improvements in quality and price; enhancing technology investment by supporting young businesses and entrepreneurs.
- **Documentation and Follow Up**: progress tracking of Digital Agenda and provision of related public documentation.

The United Nations International Telecommunication Union (ITU) has completed several plans and projects to enhance the Paraguayan ICT industry, including:

[46] International Telecommunications Union

- Bottoms-up cost modeling of fixed and mobile telecommunications focused on healthy competition among fixed and mobile service providers, service charge predictability over time, and reduction of service charges to consumers (complete 2018);
- Support of CONATEL in priority areas within the telecommunications sector – revision of National Telecommunications Plan and support of capacity building (complete 2016);
- Development of CONATEL regulatory capacity – supporting structuring and functioning of the regulatory agency in a competitive environment (complete 2013);
- Enhancement of ITU CoE-Tap Telecom Phase 1 – focused on building capacity across the Americas (primarily in Latin America and the Caribbean) including network engineering, network operations, services, and applications; ensuring the quality of service; support of the ICT sector as a strategic socio-economic enabler (complete 2009); and
- Regional support for transition from analog to digital broadcasting in the Americas.

4.3 Regulatory Landscape

The principal telecommunications regulator in Paraguay is the Comisión Nacional de Telecomunicaciones (CONATEL). Headquartered in Asuncion, CONATEL oversees planning, organization, control, and regulatory compliance across telecommunications activities and projects. This regulator also monitors the continuous expansion of ICT infrastructure and technology.

The Ministerio de Tecnologías de la Información y Comunicación de Paraguay (MITIC) was created in 2016 as the technical entity and governing body for Information and Communications Technologies in the public sector and represents communication for the executive branch. Its actions align with the ICT-related sections of Paraguay's National Development Plan 2030. MITIC's goals are to:

- Promote, increase, and facilitate the use of Information and Communications Technologies (ICTs).
- Promote the development and strengthening of the sector, technological innovation, and digital economy, through public policies that involve at all levels of State Agencies and Entities (OEE) and society.
- Develop Communication processes and strategies for the dissemination of information generated by State Agencies and Entities (OEE) and the Paraguayan part of the Binational or Multilateral Agencies, so that the dissemination of information is carried out with transparency between the Executive Branch and the inhabitants of the Republic.
- Develop, promote, implement, and monitor public policies, plans, programs, and projects in the ICT and convergent sectors.

The fixed telephone line market in Paraguay is a state monopoly with quite limited service. As a result, the mobile telephone market, served by four competing providers, has grown quite quickly. Today, there are 18 mobile lines for each fixed line in Paraguay. [47] Internet, television, and radio

[47] CIA World Factbook

markets also have competitive participants, although one state-owned radio network and several community-based radio stations also exist.

4.4 ICT Sectors Profiled

The Paraguayan ICT sector offers numerous opportunities for investment and further development across all segments. Significant public initiatives reviewed in this Resource Guide span:

- Subsea Communications Infrastructure;
- Data Centers and Cloud Computing; and
- Smart Cities and e-Government.

While the pandemic is likely to protract investment somewhat, consumer demand and government interest suggest substantial future investment opportunities for all major ICT subsectors.

4.1.1 Subsea Communications Infrastructure

Because of Paraguay's landlocked geography, it has no direct ocean access and no subsea fiber optic cables or landing stations of its own. The Paraguayan Ministry of Technologies of Information and Communication (MITIC) has recently undertaken a first subsea-related project which will grant Paraguayan citizens and enterprises direct access to this global, high-speed communications network.

The project will develop a high-capacity fiber optic cable to link Asunción, Paraguay with the submarine cable system at the Las Toninas landing station in Argentina. The project will create internet protocol (IP) transit managed by the government of Paraguay. Several options exist at Las Toninas for international subsea connections, including the ARSAT, Telefonica, Silica Networks, and Telecom Argentina cables. The effort involves a 20-year service contract, the rental of dark optical fiber (cable installed and operable but not yet in use) to one of the operators having fiber deployed in the geographic section of interest, and the purchase of equipment necessary to illuminate this fiber. The project is profiled in Section 4.5 of this Resource Guide (Project PY1).

4.1.2 Data Centers and Cloud Computing

Data centers and cloud computing are closely interrelated. Data centers provide storage for large amounts of digital information. Cloud computing, simply, is accessing and storing information and programs that do not reside on the computer a user is accessing, but rather via the internet, with the data/programs stored remotely in a data center.

In Paraguay, the data center and cloud computing industries are young and developing. IPXON, which hosts a variety of data centers in Latin America and the United States, operates a small co-location data center in Asunción, serving a limited base. Several non-Paraguayan firms, mostly U.S. and European based, but with at least one Argentine provider, offer cloud services.

A key initiative of the government is the creation of a government data center by 2024. The Ministry of Technologies of Information and Communication (MITIC) is overseeing the planning and development of this data center, which will include a government/private cloud service, an Internet Exchange Point (IXP), and a network Operations Center (NOC)

Implementation will follow a modular approach, resulting in a Tier III facility, with 99.982 percent availability and no more than 1.57 hours of annual downtime.

4.1.3 Smart Cities and e-Government

The UN ranks Paraguay as an upper-middle-tier nation in terms of connectivity and e-government. Paraguay has continually addressed national ICT infrastructure limitations and is actively improving the availability and reducing the cost of broadband access, which will allow the country further smart city and e-government development.

Similarly, Paraguay has continually upgraded and sought to expand citizen access to telephony and the internet. Projects identified to continue the country's progress include: a high-capacity fiber optic cable linking the capital city, Asunción, to the international subsea fiber optic cable network via the landing station at Las Toninas, Argentina, and the development of a Digital District in Asunción, intended to become the country's focal point for ICT innovation. The 2020 COVID-19 global pandemic has afforded improvements in Paraguay's e-government capabilities including enhanced telemedicine and improved citizen/medical care worker information provision.

4.5 Projects Profiled

Three Paraguayan ICT development projects are profiled following (*Table 13*).

Table 13: ICT Development Projects – Paraguay

ICT Project	Sponsor
Subsea Communications Infrastructure	
Paraguay International Connectivity Project	Ministry of Technologies of Information and Communication (MITIC)
Data Centers and Cloud Computing	
Paraguay Government Data Center (also *Smart Cities and e-Government*)	Ministry of Technologies of Information and Communication (MITIC)
Smart Cities and e-Government	
Paraguay Digital District	Ministry of Technologies of Information and Communication (MITIC)

PARAGUAY INTERNATIONAL CONNECTIVITY PROJECT	
SUBSECTOR	**Subsea Communications Infrastructure**
LOCATION	**Paraguay and Argentina**
PROJECT VALUE	**$42 million**

PROJECT SUMMARY

- A high-capacity fiber optic cable will link Asunción, Paraguay to the Las Toninas, Argentina submarine cable landing station, increasing high-speed internet connectivity.
- The project sponsor is the Paraguayan Ministry of Technologies of Information and Communication (MITIC).

PROJECT BACKGROUND AND DESCRIPTION

Because Paraguay is landlocked, with no existing direct access to the high-capacity submarine cable system, IP transit prices are higher in Paraguay than in most neighboring countries. Today, the cost of deploying internet access from wholesale suppliers in Buenos Aires to Asunción increases local final internet service prices by a factor of five. The resulting price level has impacted the economy and the country's competitiveness, as well as citizen access to the internet.

Paraguay is striving to upgrade its broadband infrastructure to improve internet access speeds. The country is currently ranked 148th globally for internet download speed (*Table 14*).

Table 14: Select Country Internet Download Speed Comparison[48]

Rank	Country	Average Download Speed (Mbps)
10	United States	18.7
20	Canada	16.2
57	Uruguay	9.5
60	Chile	9.3
76	Mexico	7.5
79	Brazil	6.8
90	Argentina	6.3
148	Paraguay	1.4

[48] Akamai as referenced by MITIC

To meet growing citizen, enterprise, and government demand for data traffic, technical benefits from project implementation will include:

- Increased high-speed internet connectivity;
- Decreased latency; and
- Higher capacity and quality in international transmission/unloading.

Socio-economic development is a key driver behind this project. Thus, the project will also provide considerable economic and social development benefits, both directly and indirectly, including:

- Reduced international IP transit cost;
- Reduced final price of broadband (or delivery of higher speeds at comparable rates);
- Development of local entrepreneurs in the internet industry;
- Increased reliability and redundancy of internet networks;
- Increased foreign investment;
- Increased internet penetration rates; and
- Support for elements of the country's digital agenda, such as e-government services.

The project consists of two segments:

1. Deploy high-capacity, multi-service, dense-wavelength-division-multiplexing (DWDM) carrier-class equipment along the entire route from a data center in Asunción to the city of Clorinda in Formosa Province, Argentina, the site of the international connection.
2. Deploy high-capacity, multi-service, DWDM carrier-class equipment, and a 48-strand Optical Fiber cable from the city of Clorinda to the international connection at the landing station in Las Toninas via the Point of Presence (PoP) in the existing Data Center of the City of Buenos Aires. Shelters and pipelines will be built throughout the network's deployment route to connect to the submarine cable system.

The project runs a total distance of 1,600 km, from Asunción to the landing station in Las Toninas (*Figure 40*).

The project includes a Network Operations Center (NOC) to be located in Asunción. MITIC will manage the NOC, operating and maintaining the entire network infrastructure, including network monitoring, call reception, service ticket tracking, and failure resolution. The project also includes several regional infrastructure maintenance groups to assess and physically resolve fiber optic and equipment issues.

Figure 40: Project Map – High-Capacity Fiber Optic Cable from Asunción to Landing Station at Las Toninas

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The International Connectivity project is at its initial planning stage. MITIC estimates a 3-year implementation timeline to include the following phases:

- Feasibility study;
- Implementation planning;
- Tendering and contracting;
- Final engineering;
- Permitting;
- Construction activities;
- Equipment installation; and
- Commissioning.

PROJECT COST AND FINANCING

MITIC has estimated a budget of $42 million to implement the project. The Ministry estimates the two most significant cost components to be construction ($24 million) and fiber optic cable ($8 million). Operating expenses are forecast by MITIC to be $2 million annually. The feasibility study will confirm budget estimates and explore potential financing sources for project implementation.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. firms include:

- Fiber optic cabling hardware;
- DWDM modules and associated hardware;
- Fiber optic network management hardware and software;
- Splitting/switching equipment;
- Conduit and sheltering materials and products;
- Network modeling, design, and engineering services;
- Construction services/oversight;
- Installation/testing services/oversight;
- Other technical and management advisory services including support of the feasibility; study, project development, construction, and operations; and
- Technical service organization development and training support services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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PARAGUAY GOVERNMENT DATA CENTER	
SUBSECTOR	**Data Centers and Cloud Computing**
LOCATION	**Paraguay**
PROJECT VALUE	**$23 Million**

PROJECT SUMMARY

- A new public-sector data center in Asunción will provide cloud, hosting, and other IT services to all government entities, thus facilitating the adoption of e-Government solutions.
- The data center will also house a Network Operations Center (NOC) to operate and maintain the entire network infrastructure, including the activities of CERT-PY, the national cybersecurity response agency.
- The project sponsor is the Paraguayan Ministry of Technologies of Information and Communication (MITIC).

PROJECT BACKGROUND AND DESCRIPTION

The prospective data center will house 1,680 servers. The data center design provides for servers organized in 40 racks of 42 servers each, structured as six rows of racks across two different server rooms. The configuration will require 240kW of power availability. The design of the data center building will allow modular expansion to double this capacity in the future.

Paraguay intends to have the data center certified to Tier III (concurrently maintainable) of the Uptime Institute's scale. Tier III data centers have 99.982% availability, with a maximum annual downtime of 1.57 hours.

Tier III data centers require no shutdowns for equipment replacement and maintenance, something achieved through redundancy of all key power and cooling systems. Critical characteristics of Tier III data centers include:

- Dedicated space for IT systems;
- Redundant uninterruptible power supply (UPS) to filter power spikes, sags, and momentary outages;
- Redundant dedicated cooling equipment which does not shut down at the end of regular office hours;
- A redundant engine generator to protect IT functions from extended power outages; and

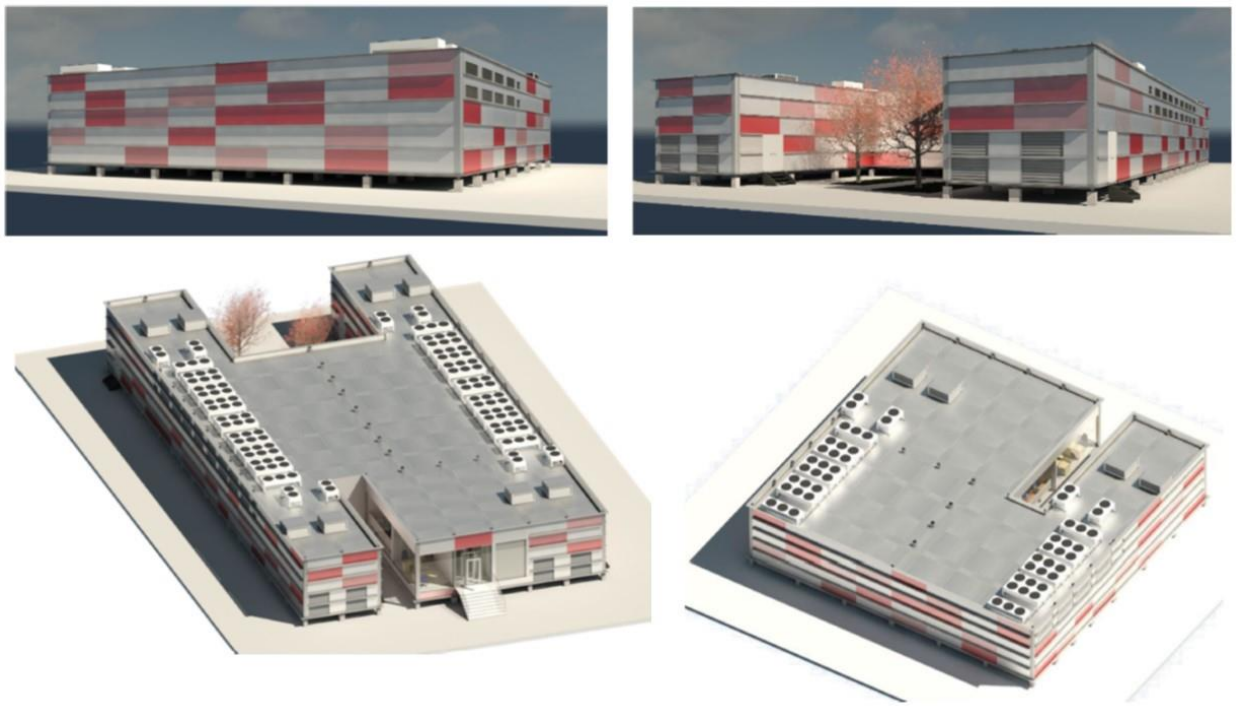
- A redundant delivery path for power and cooling, so every component needed to support the IT processing environment can be shut down and maintained without impacting the overall IT operation.

The data center will be divided into the following areas:

- External carrier room;
- Telecommunications and internet exchange points;
- Server and IT rooms;
- UPS and batteries;
- Storage area;
- Network operations center (NOC);
- Cyber incident response (CERT-PY) center;
- Crisis management center;
- Meeting rooms;
- Diesel engine generator sets and fuel storage; and
- Other: training, maintenance, reception, security, *et al*

The data center design criteria also contemplate world-class energy efficiency. Provide below is an artist's rendering of the proposed data center (*Figure 41).*

Figure 41: Artist's Rendering – Paraguay Government Data Center



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project is in its initial design phase. Key implementation milestones include:

Date	Key Milestone
July 2022	Initiate construction contracting process
December 2023	Data center constructed
January 2024	Initiate IT equipment contracting process
January 2025	IT equipment installed
June 2025	NOC equipment installed

PROJECT COST AND FINANCING

Project implementation has a total budget of $23 million, broken down as follows:

Project Component	Budget ($000)
Engineering and design	637
Data center construction	11,096
Construction supervision	181
Tier III certification	514
Data center equipment	6,572
NOC equipment	4,000
Total	***23,000***

The Inter-American Development Bank (IDB) is providing implementation financing under a $130 million loan, PR-L1153: Paraguay Digital Agenda Support Program. The overall program has four specific objectives:

- Reduce the transaction costs involved in accessing public services for citizens and companies;
- Increase the use of information and communications technologies and incentivize business innovation and linkages;
- Increase access to broadband by expanding connectivity and improving service quality; and
- Strengthen the institutional framework and operational capacity of the government to foster the development of the Digital Agenda.

The program comprises four components, of which the Paraguay Government Data Center falls under number three (*Table 15*).

Table 15: IDB Paraguay Digital Agenda Support Program Components

Component	Objective	Budget ($ million)
1	Digitize processes; improve public sector service delivery	32.6
2	Improve ICT investment - support youth, entrepreneurs, and companies	29.6
3	Expand broadband use; improve broadband price/quality	47.9
4	Strengthen institutional framework and government's capacity to develop the Digital Agenda	13.4

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies include:

- Server-related componentry and racking;
- Power and power backup equipment (power supplies, batteries, generators, *et al*);
- HVAC equipment and associated design and installation services;
- Site operations/security systems and services;
- Cybersecurity software, services, and training;
- Data center design, planning, and engineering services; and
- Network operations services and training.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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PARAGUAY DIGITAL DISTRICT	
SUBSECTOR	**Smart Cities / e-Government**
LOCATION	**Asunción**
PROJECT VALUE	**$9.5 Million**

PROJECT SUMMARY

- The Paraguay Digital District is a seven-hectare development destined to become the core cluster of the country's IT sector.
- The project sponsor is the Paraguayan Ministry of Technologies of Information and Communication (MITIC).

PROJECT BACKGROUND AND DESCRIPTION

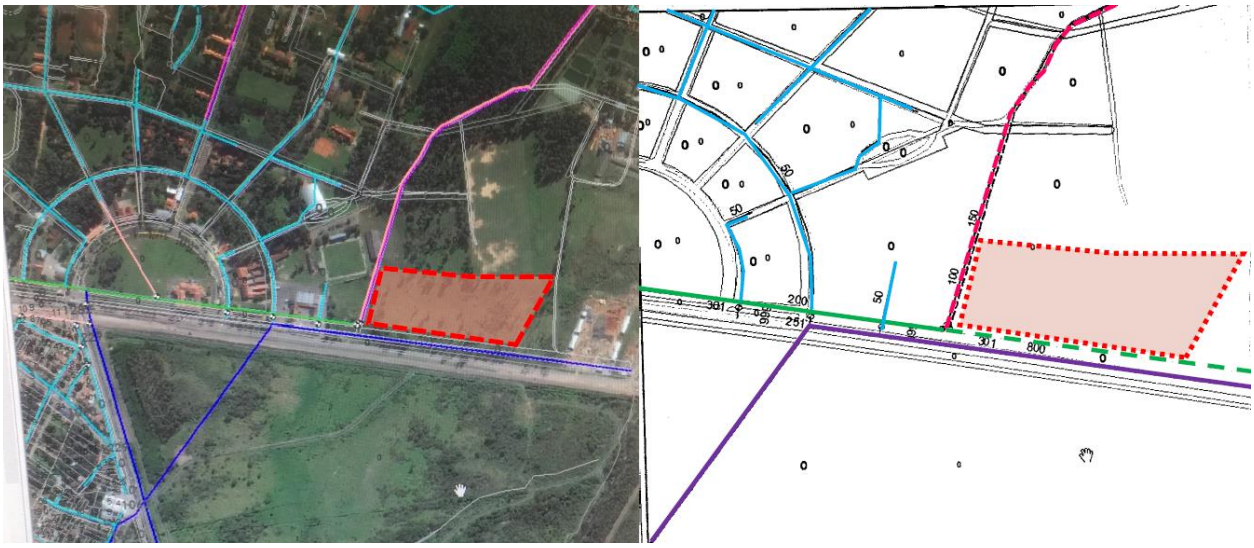
The general objective of Paraguay's Digital District is to foster the development of an innovation ecosystem, creating synergies for the use of technological infrastructures and Industry 4.0 capabilities. Its mission will be to incorporate value in production chains, develop new products and services, and create new business opportunities both locally and internationally. The Digital District is not the simple creation of infrastructure or establishment of a state agency. Rather, it will be the focal point for growing a regional innovation system, strengthening the links between academia, industry, and government, and resulting in improved Paraguayan national competitiveness.

The Digital District will be situated in Asunción on land to be donated by the armed forces (*Figure 42*). The site is a seven-hectare plot on the Ñu Guazú / Gral. Andres Rodriguez Highway across from Guazú Metropolitan Park, near the airport.

The design for the Digital District has contemplated other similar technology clusters, including:

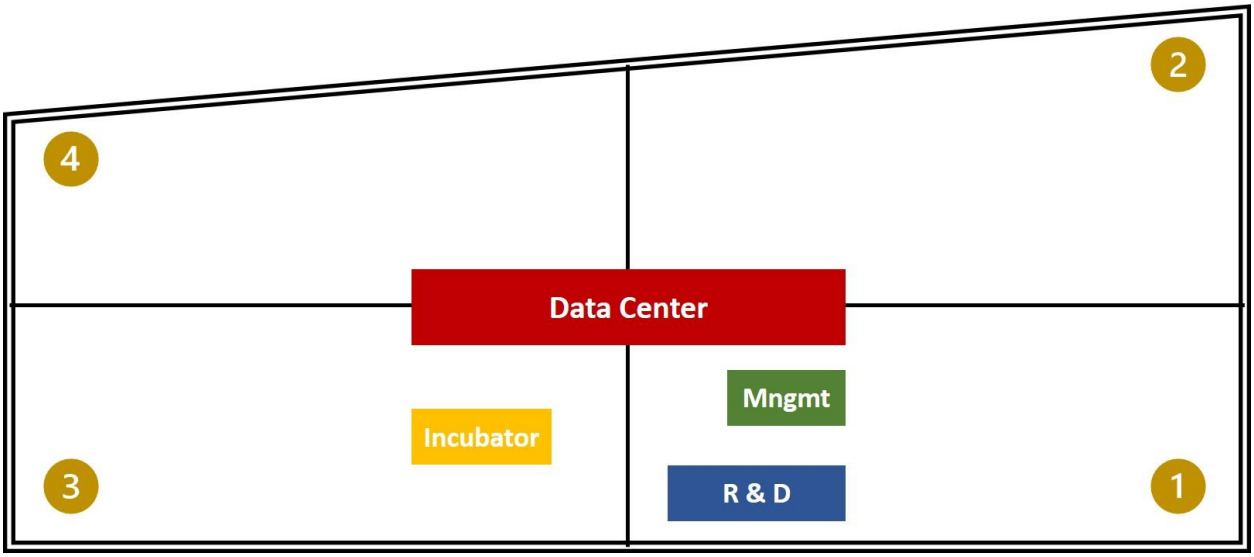
- Porto Digital, Recife, Brazil;
- Ruta N, Medellin, Colombia;
- 22@Barcelona, Spain; and
- PCT de Pando, Uruguay.

Figure 42: Digital District Map – Asunción



The Digital District is divided into four quadrants to facilitate a phased build-out over time. The initial configuration includes a data center, an incubator, a research and development site, and management accommodations (*Figure 43)*.

Figure 43: Proposed Initial Layout for the Digital District



The "magnet" facility of the Digital District is the new Paraguay Government Data Center, described separately in this Resource Guide. Additional facilities planned for the initial phase include:

- **Incubator** - incubation facilities for startups that share administrative areas, meeting rooms, and co-working space. The incubator's main functions are training and awareness development for entrepreneurs (education in business models, digital marketing, marketing, *et al*), pre-incubation of proposals (transforming ideas into potential ventures by helping to develop prototypes or concept tests), and business nurturing.

- **Technology Center** - bringing together researchers from the ICT sector and 4.0 industries from leading Paraguayan universities. The Technology Center will be agile, i.e., able to orient capacity and flexibility rapidly toward the research needs of the productive, social, and environmental sectors. Technology transfer, the development of sector services, and collaboration with industry are key factors in setting up the Technology Center's operations.

- **Business Management Unit** - promoting the relationship among the various constituents and managing the infrastructures. This Unit will offer financial management services, intellectual property guidance, and business management assistance to all partners. A board of directors, including representatives from all involved parties – industrial, academic, and public, will govern the effort. For efficiency, the Unit will outsource many of its functions.

The Digital District will also have support facilities, including reliable power supply, fiber optic data connections, surveillance/security systems, and infrastructure for access, comfort, and safety.

The Digital District's Master Plan comprises three five-year periods, for a total development horizon of 15 years. Beyond the initial build-out shown above, the Digital District will focus on attracting ICT sector companies. Once the first phase is complete, the strategic plan will evaluate the viability of fiscal incentives to attract new partners (e.g., income tax holidays, exemptions from employer contributions, VAT reductions or exemptions for construction and installation expenses, and favored duty scheme).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Digital District project is in its initial design phase. Key implementation milestones for the first five-year build-out period include:

Date	Key Milestone
December 2020	Initiate construction contracting process
June 2021	Initiate construction of the digital district
January 2023	Initiate operation contracting process
February 2023	Digital district constructed
June 2023	Initiate digital district operation
June 2025	End of first 2-year operation contract

The Digital District's management unit will prepare milestones for future build-out phases once the first phase is consolidated.

PROJECT COST AND FINANCING

The budget for Digital District Phase One project implementation is $9.5 million, broken down as follows:

Project Component	Cost ($000)
Design and specifications	240
Digital district construction	8,313
Construction supervision	96
Digital district equipment	300
2-year operation	551
Total	***9,500***

The Inter-American Development Bank (IDB) is providing implementation financing under a $130 million loan, PR-L1153: Paraguay Digital Agenda Support Program. The overall program has four specific objectives:

1) Reduce the transaction costs involved in accessing public services for citizens and companies.
2) Increase the use of information and communications technologies (ICT) and incentivize business innovation and linkages.
3) Increase access to broadband by expanding connectivity and improving service quality.
4) Strengthen the institutional framework and operational capacity of the government to foster the development of the Digital Agenda.

The program also comprises four components, of which the first phase of the Digital District falls under number two (*Table 16*).

Table 16: IDB Paraguay Digital Agenda Support Program Components

Component	Objective	Budget ($ million)
1	Digitize processes; improve public sector service delivery	32.6
2	Improve ICT investment by supporting youth, entrepreneurs, and companies	29.6
3	Expand use of broadband; improve broadband price and quality	47.9
4	Strengthen institutional framework and government's capacity to develop the Digital Agenda	13.4

U.S. EXPORT OPPORTUNITIES

The phase one Digital District project offers numerous opportunities for U.S. companies, including:

- Office furniture and fittings;
- Specialized R&D and technology development equipment and training;
- General/office IT/communications equipment, software, technical support, and training;
- Financial and intellectual property-related software and support services; and
- Entrepreneurial and technology management support and training.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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ANNEX A: ICT SECTOR OVERVIEWS

A1 TERRESTRIAL COMMUNICATIONS NETWORK INFRASTRUCTURE: TELEPHONE, INTERNET, and BROADBAND

A1.1 Sector Overview

The vast majority of ICT network infrastructure resides on land. Nonetheless, key transmission infrastructure also exists in space (see *Satellites*) and on the ocean floor (see *Subsea Communications Infrastructure*).

Communications networks may be wired, wireless, or a combination of the two and may be as simple as the connection of devices within a home or as complex as serving millions of subscribers throughout a country or across the globe. Although modern technology has blurred the lines in terms of ICT networks and service crossovers, three key areas represent the majority of global communications:

- Telephony
- Broadband
- Internet

Terrestrial communications network infrastructure spans:

- Hardware and devices,
- Software and firmware,
- Network equipment,
- Supporting systems such as power, cooling, security, and dedicated facilities,
- Computing, application, and content platforms, and
- Related services including telecommunications, broadband, and internet access, as well as service delivery.

A1.1.1 Telephony

For many decades, telephony was the principal mode of remote human communications. First introduced conceptually by Antonio Meucci, whose 1871, Alexander Graham Bell is more generally recognized as the inventor of the telephone. Telephony remained primarily analog/wired until the 1970s, when Martin Cooper, a Motorola engineer, developed the first-generation mobile telephone. In 1979, Nippon Telephone and Telegraph (NTT) deployed the first mobile network (using analog signals). In 1987, various European nations agreed to the use of GSM, or the second generation of mobile telephony -- digital, cellular, and with uniform standards. The adoption of mobile telephony was rapid thereafter (*Table 17*).

Table 17: Evolution of Mobile Telephony[49]

Generation	Speed	Technology	Key Features
1G (1970-1980s)	14.4 Kbps	AMPS, NMT, TACS	Voice only
2G (1990-2000)	9.6/14.4 Kbps	TDMA, CDMA	Voice and data
2.5-2.75G (2001-2004)	171.2 Kbps 20-40 Kbps	GPRS	Voice, data and web mobile internet, low-speed streaming services, and e-mail services
3G (2004-2005)	3.1Mbps 500-700 Kbps	CDMA2000 (1xRTT, EVDO) UMTS and EDGE	Voice, data, multimedia, support for smartphone applications, faster web browsing, video calling, and TV streaming
3.5G (2006-2010)	14.4 Mbps 1-3Mbps	HSPA	All 3G capabilities with enhanced speed and mobility
4G (2010-present)	100-300 Mbps 3-5 Mbps 100 Mbps WiFi	WiMAX LTE WiFi	High speed, high-quality voice over IP, HD multimedia streaming, 3D gaming, HD videoconferencing, and worldwide roaming
5G (2019 forward)	1-10 Gbps	LTE advanced schemes OMA and NOMA	Super-fast mobile internet, low latency network for mission-critical applications, Internet of Things, security and surveillance, HD multimedia streaming, autonomous driving, and smart healthcare applications

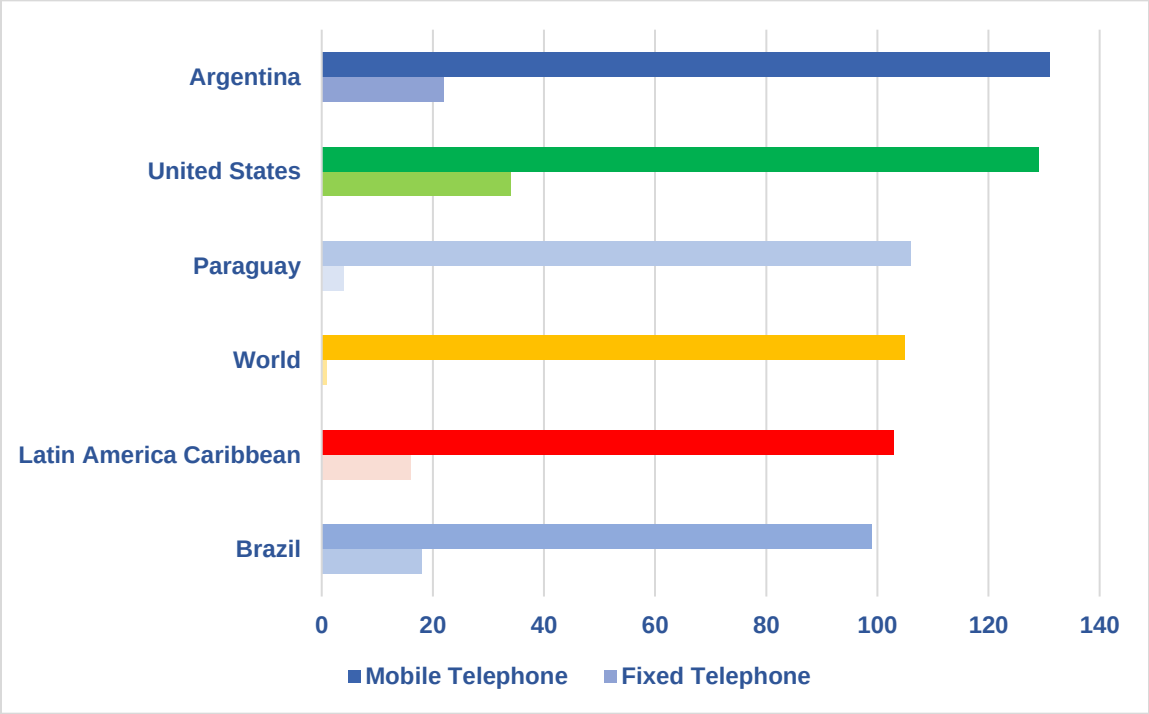
From 1987 to the present, the world has witnessed several new generations of mobile telephony. Each successive innovation provides faster speed, lower latency, and a wider range of capabilities in terms of content transmission capability. The current focus is on the successful implementation of 5G technology, which offers the ability to handle standard voice and data communications, and the ability to power Internet of Things (IoT) devices, artificial intelligence (AI), and a wide array of other data-intensive applications.

[49] RFPage.com

While fixed telephony still exists worldwide, mobile telephony has been a boon to economically developing societies, giving more citizens telephone access more quickly due to less cumbersome infrastructure installation requirements. Typically, countries with earlier economic development trajectories have higher remaining use of fixed telephony, while those later-to-develop have higher levels of mobile to fixed telephone usage (*Figure 44)*.

The Latin American/Caribbean region exceeds world levels in fixed telephony access and is just below world levels for mobile telephone penetration on a population-adjusted basis. Argentina exceeds regional, world, and U.S. levels of mobile telephony penetration, while still maintaining a sizeable fixed telephony presence. Paraguay has higher mobile telephony penetration than world averages, but a small installed fixed telephony base. Despite having a well-developed ICT industry, Brazil lags both regional and world levels for mobile telephony, due, in part, to the geographic challenges of connecting remote regions distant from the country's highly-populated Atlantic coast.

Figure 44: Fixed and Mobile Telephone Usage – Subscriptions per 100 People[50]



New technology developments include:

- Deployment of 5G (fifth generation) mobile telephony -- with faster speeds, lower latency, and ability to carry vast amounts of information, 5G will make demanding IoT and AI applications more feasible.

[50] World Bank

- Expanded use of SD-WAN (software-defined wide area network) -- this cloud-based architecture will continue the path of abstracting software from hardware to provide more elastic traffic management and WAN virtualization.

- Development of a sixth-generation (6G) approach to telecommunications -- using frequencies between 100 GHz and 1 THz. Still in the early development stages, industry experts expect 6G may require a decade of development but could offer speeds up to one terabyte (TB) per second. That is the equivalent of 142 hours of movies delivered in one second.

A1.1.2 Internet

The internet is a global computer network consisting of interconnected networks using standardized communication protocols. It links smaller computer networks, including commercial, educational, governmental, and other, all of which use the same set of communications protocols. Also called the World Wide Web (with the terms are frequently used interchangeably), technically, the internet comprises the physical infrastructure elements. The World Wide Web is software (i.e., the large collection of webpages connected by hyperlinks) and is a service of the internet.

The internet effectively began in 1965, when Lawrence Roberts and Robert Merrill connected two computers via a low-speed telephone line, one in Massachusetts and one in California. By 1969, a better-developed version of the internet, ARPANET, was demonstrated among computers at Stanford University and the University of California at Los Angeles (UCLA). By 1995, or in just under 25 years, 16 million people had begun using the internet. By 2005, a billion users were accessing the internet and as of 2019, over 4 billion[51]. Today, citizen internet access and usage is considered a barometer of the economic development of nations.

As the internet has developed, rapid changes to hardware, software, and networking technologies have increased utility and speed. Networks have moved from telephony-based to high-speed, high-capacity fiber optic cables and wireless. Content has shifted from simple text to the ability to stream dense video, photographic, and music content worldwide. Access has moved from desktop computers to small mobile devices, especially cellular phones. User now connect anywhere in the world with but milliseconds of lag from anywhere else.

Technologies in development to extend internet utility include:

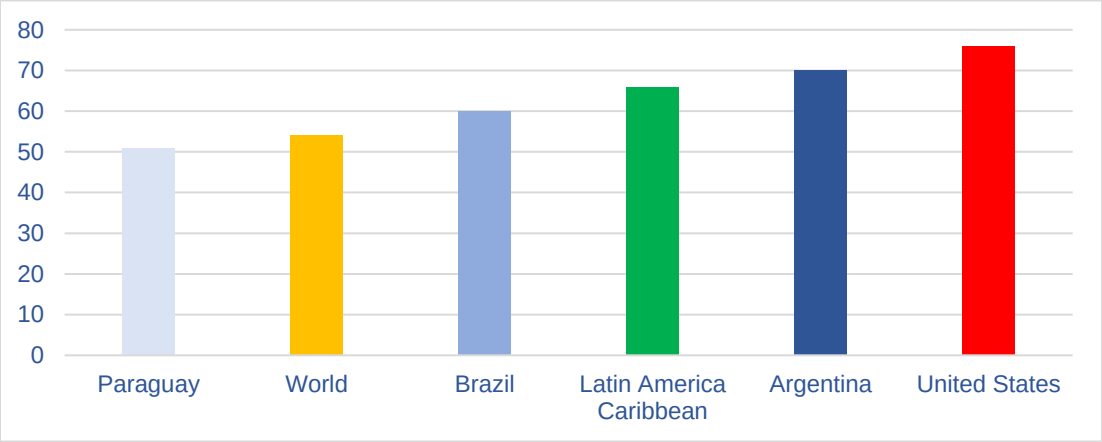
- **5G Data Networks** – super fast data networks allowing better streaming capabilities at lower latency.
- **Internet of Things (IoT)** -- increased bandwidth allows for high-data-intensity new applications such as autonomous driving vehicles, smart machines, and advances in telemedicine, including predictive diagnostics.
- **Computer Vision** – automated, digital visioning.

[51] HootSuite

- **Artificial Intelligence** -- computer system ability to perform tasks previously requiring human intelligence (e.g., visual perception, speech recognition, decision-making, and translation between languages).
- **Virtual and Extended Reality** – used today primarily for entertainment, but also for simulation, training, and other professional uses. The user allows the computer to create a virtual world and block out the real one.
- **Blockchain** – a digital ledger to record transactions secured via encryption and decentralized. Cryptocurrencies are the medium of exchange, including perhaps the best known, Bitcoin, along with others such as Ether (Ethereum), Binance, zCash, Monero, and Facebook's Libra, which is shifting in scope due to regulatory pressure.

Internet usage in the Latin American/Caribbean region is currently above world levels (*Figure 45*) but significantly lags the United States.

Figure 45: Internet Usage Penetration - 2018[52] (Percent of Population Having Internet Access)



A1.1.3 Broadband

Broadband is a high-capacity transmission technique using a wide range of frequencies, enabling a large number of messages or other content to be communicated simultaneously. The term broadband commonly refers to high-speed internet access that is always on and faster than the historical dial-up access. Several high-speed transmission technologies comprise broadband, including:

- **Digital Subscriber Line (DSL)** - a wireline transmission technology over traditional copper telephone lines already installed to homes and businesses with transmission speeds ranging from several hundred kilobits per second (Kbps) to millions of bits per second (Mbps).

[52] World Bank

- **Cable Modem** - broadband provided using the same coaxial cables that deliver pictures and sound to a television. Cable modems are typically external devices with two connections, one to the cable wall outlet, the other to a computer, and operate at transmission speeds of 1.5 Mbps or more. It is possible both to use broadband and watch television simultaneously.

- **Fiber** - converts electrical signals carrying data into light and sends the light through transparent glass fibers about a human hair's diameter. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber may run to the customer's home or business, the curb outside, or a location somewhere between the provider's facilities and the customer.

- **Wireless** - a radio link between the customer's location and the service provider's facility, either mobile or fixed. Wireless technologies using longer-range directional equipment can provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly. Speeds are generally comparable to DSL and cable modem. An external antenna is usually required.

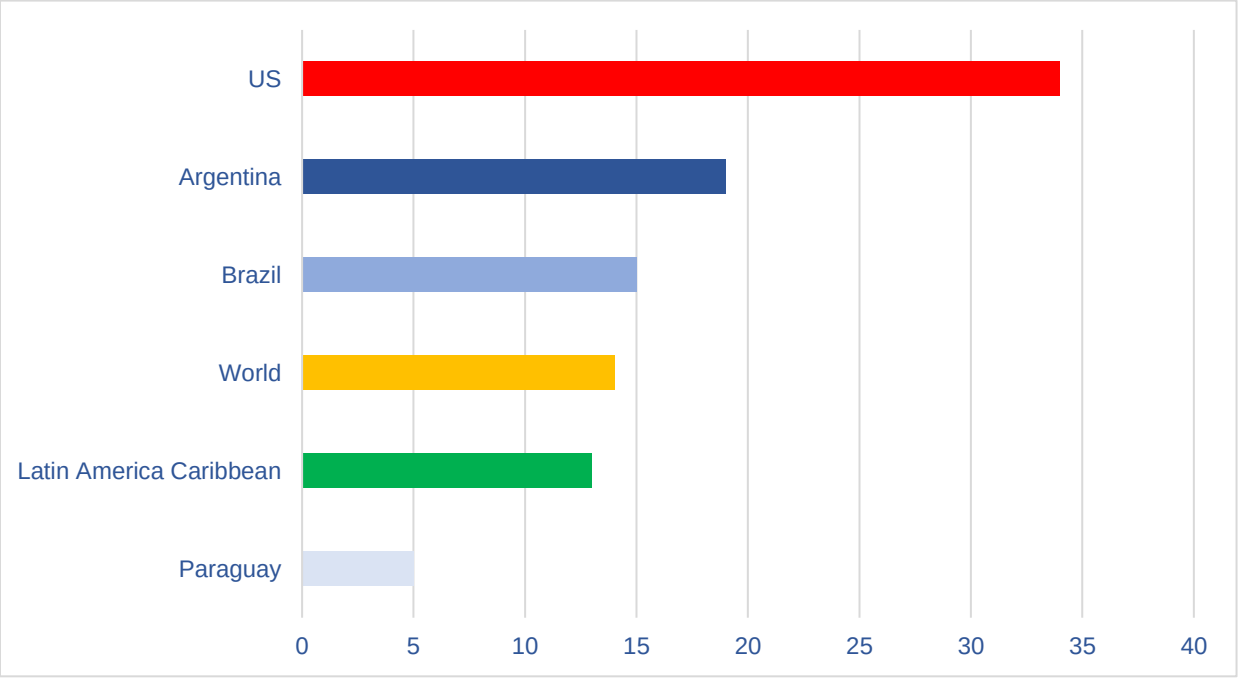
- **Satellite** - satellites orbiting the earth provide vital links for telephone and television service, and also create wireless links for broadband useful for serving remote or sparsely populated areas. Consumers may expect to receive (download) at 500 Kbps and send (upload) at 80 Kbps. These speeds may be slower than DSL and cable modem, but they are about ten times faster than the download speed with dial-up Internet access. Extreme weather conditions, however, may cause service to be disrupted.

- **Broadband over Powerlines (BPL)** - delivery of broadband over the existing low- and medium-voltage electric power distribution network. BPL speeds are comparable to DSL and cable modem speeds. Power lines are installed virtually everywhere, thus alleviating the need to build new broadband facilities.

Broadband's origins date to the 1960s, contemporaneous with the early internet development. By 1969, prestigious colleges on the U.S. east and west coasts had 50Kbps or better broadband connections. In 1984, these colleges adopted T1 (voice and data) lines, foregoing the use of the previous 50Kbps channels. In the early 1990s, businesses began to use broadband, and by 2000-2001, home use was growing rapidly. Since the dawn of the millennium, global citizen access, upload and download speeds, and service consistency and reliability have continued to improve.

The Latin American/Caribbean region somewhat lags world levels for fixed broadband subscriptions per 100 people (*Figure 46*). Brazil and Argentina are well above world levels. In Paraguay, mobile cellular access to the internet is more prevalent.

Figure 46: Fixed Broadband Subscriptions per 100 People, 2018[53]



New broadband technologies overlap those for telephony and the internet and include implementation of the 5G network and eventual development of a 6G network. Certain futurists are beginning to ask the question as to whether fixed, even fiber-based, broadband may become obsolete in future telecommunications generations with speeds above 1Tbps, assuming wireless technologies can solve issues such as line-of-sight.

A1.2 Terrestrial Communications Network infrastructure - Investment Outlook

The value of global telecommunications services was $1.7 trillion in 2019[54] and expected to grow at a compound annual growth rate of 5 percent from 2020-2027. Continued increases in demand for consumer wireless telephone services, mobile access, and cloud-based technologies drive demand for high-speed telephone, internet, and broadband connectivity. Despite strong individual consumer demand, the commercial segment recently has accounted for most growth. Commercial application foci include data reliability and quality, both for customers and internally for videoconferencing, high-security intracompany networks, and corporate calling and texting.

Global internet (web) hosting services reached $61 billion in 2018 and will grow at a compound annual growth rate of over 15 percent through 2026.[55] Growth drivers include expanding individual consumer demand for greater access to web-based shopping, household device connectivity, and mobile access.

[53] Ibid
[54] Grandview Research
[55] Fortune Business Insights

Global broadband services were valued at $327 billion in 2019 and projected to grow at a compound annual growth rate of nine percent through 2027.[56] Digital transformation of several industry verticals, along with ever-expanding consumer demand and access, is driving growth. While the COVID-19 global pandemic has slowed growth in some sectors, broadband usage for e-learning and digital healthcare has grown rapidly.

Overall, market size for this sector in the Latin American/Caribbean region exceeded $100 billion in 2018. Growth in multichannel and fixed broadband/internet services outpaced that in fixed and mobile telephony, which are more mature technologies.[57]

A1.3 Argentina

Argentine Terrestrial Communications Network Infrastructure is well developed with generally globally competitive levels of mobile telephone, internet, and broadband usage. The country's citizens have enjoyed rapid growth in access to communications services. During 2020, as a result of the COVID-19 global pandemic, the Argentine government has frozen mobile telephone, internet, and digital television prices until December, deeming these "essential services." Any price increases require advance government approval.

Mobile telephone providers in Argentina include Claro, Movistar, Nextel, and Personal, and service companies. Argentina first tested a 5G system in 2017, with Movistar demonstrating a record speed of 20 Mbps using Ericsson's 28 GHz testbed. Commercial availability of 5G will likely progress slowly through the mid-2020s.

Major internet service and broadband providers in Argentina include Telecentro, Cable Vision, Movistar, Claro, and Telered. In 2019, four companies dominated fixed broadband: Grupo Clarin, Grupo Telofnica, Grupo Telecentro, and Grupo Supercanal, with numerous others representing circa the remaining 20 percent. Multiple regional providers also exist. Mobile and fixed broadband speeds in Argentina averaged 27.77 and 44.28 for download, 9.76 and 11.87 Mbps for upload, and 40 and 29 milliseconds for latency, respectively, in August 2020,[58] or positioning Argentina at 73rd in the world.

A1.4 Brazil

Brazil hosts a sophisticated terrestrial communications network infrastructure, although coverage across the country varies appreciably.

Mobile telephony has enjoyed generally strong growth in Brazil. The 2020 COVID-19 global pandemic has weakened revenues and growth due to consumer caution/lack of income, closure of retail outlets for phone purchases, and unavailability of imported handsets and related components. The largest mobile telephony providers include Vivo (Telefônica Brasil, a subsidiary of Portuguese

[56] Grandview Research
[57] S&P Global Market Intelligence
[58] Speedtest.net

Telefónica), Claro (América Movil), TIM (Telecom Italia Mobile), and Oi (Telemar). Implementation of 5G technology, including a spectrum auction, was planned for 2020 but has been temporarily delayed by the pandemic.

The largest internet service providers (ISPs) in Brazil include Vivo, Claro, Oi, Algar, and TIM. Because of the large landmass of Brazil, numerous regional ISPs also operate. Nearly 50 percent of internet connections in the country exceed 34Mbps. Even in smaller cities, high-speed internet access already serves 21 to 37 percent of users.[59]

The country hosts one of the largest broadband markets in Latin America. Oi (DSL) is the Brazilian broadband leader, followed by Net (mostly cable) and Vivo (DSL). In August 2020, mobile and fixed broadband speeds in Brazil averaged 28.48 and 63.73 for download, 10.18 and 37.12 Mbps for upload, and 43 and 14 milliseconds for latency, respectively, positioning Brazil at 69th in the world.[60]

A1.5 Paraguay

Mobile telephone providers in Paraguay include Tigo, Personal, Claro, and Vox, operating primarily 3G, with some 4G capabilities. In June 2020, the Paraguayan National Communications Commission head indicated there would be no 5G auction in Paraguay until 2024 at the earliest.

An array of internet service providers in Paraguay offer services ranging from dial-up to WiFi and 2G, 3G, and 4G mobile services. Internet capabilities are most sophisticated in Asunción, followed by other large metropolitan areas.

Mobile and fixed broadband speeds in Paraguay averaged 16.35 and 39.99 for download, 9.52 and 10.91 Mbps for upload, and 42 and 19 milliseconds for latency, respectively, in August 2020, positioning Paraguay at 121st in the world.[61]

[59] Latin America Business Stories
[60] Speedtest.net
[61] Ibid

A2 SUBSEA COMMUNICATIONS INFRASTRUCTURE

A2.1 Sector Overview

Subsea (or submarine) fiber optic cables are effectively the backbone of the internet today. They permit countries and continents to share information across long geographic distances. While satellite communications are highly effective, subsea fiber optic cable today is more reliable and cost-effective. In the future, some competition from Low Earth Orbit (LEO) satellites is likely.

Subsea fiber optic cables are laid on the seabed to provide a high-capacity means of transferring large amounts of information and data. Using the seabed for cable laying allows for route shortening and optimization, which reduces transmission lag (latency) and also avoids terrestrial security issues such as natural disasters and human acts such as vandalism.

Subsea cables are designed and manufactured to:

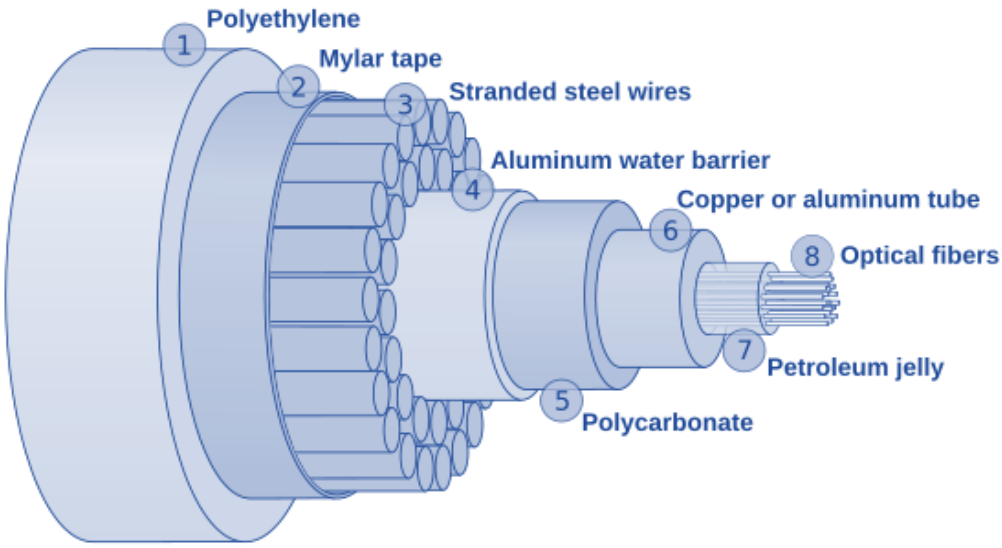
- Be installed underwater and take into account:
  - Ambient temperature (both sea and land);
  - Burial/water depth and associated pressures;
  - Nature of shore approach; and
  - Cable length.
- Be laid on the rugged and rocky seabed, as well as be buried near the shore approach.
- Withstand marine animals, tsunamis, volcanic activity, and trawls used by fishermen.

A typical subsea fiber optic cable includes numerous components, of which all but the fibers themselves are protective of the glass optical strands at the center. The optical fibers carry digital data in the form of light (*Figure 47*).

Typical subsea fiber optic cables are just under an inch in diameter and weigh 2.5 tons per km. Manufacturers typically add extra armoring for cables and cable ends residing near a shoreline. The optical fibers themselves are about the diameter of a human hair and fashioned of highly pure glass coated with a high-performance polymer such as a polyimide.

Installers typically bury near-the-shoreline cable sections under the seabed for extra protection. Before installation, route studies assess preferred alternatives to avoid hazards such as fault lines, anchoring zones, fishing areas, etc. The shortest cables, such as Google's Junior, connecting Rio de Janeiro and Santos, Brazil, are a few hundred km. Transcontinental cables run lengths of as many as ten to twenty thousand km.

Figure 47: Subsea Fiber Optic Communications Cable Construction[62]



A laser, at one end of the cable installation, transmits digital data by firing a light signal down the optical fiber. The data, in the form of the light signal, is captured on the other end by a receptor. The optical fiber performs essentially as a mirror. The laser switches on and off to send each bit. Modern fiber systems with a single laser can transmit billions of bits per second, i.e., the laser can turn on and off several billions of times per second. Newer systems use multiple lasers with different colors to fit numerous signals into the same fiber. Fibers are paired within cables, one fiber for each direction.

Fiber optic cables can carry a signal up to about 60 miles (100 km). On a long-distance line, equipment huts at intervals contain equipment to pick up and retransmit the signal, at full strength, down the next segment.

Redundancy is built into cable systems to reduce the impact of cable faults, typically by spreading network capacity over multiple cables. The function of a cable requiring downtime/repair time is managed by other cables until repairs are complete. About two-thirds of cable faults result from marine traffic (fishing and anchor dragging), with environmental issues, such as earthquakes, another major fault contributor. Occasionally underwater components fail. Sabotage and shark bites, despite urban legend, are relatively rare.

At the ends of a subsea fiber-optic cable are landing points. Landing points are selected to have silty bottoms to allow the line's burial to protect it from damage, mild currents to ensure the cable's positional stability once buried, and minimal marine traffic. Multiple cables frequently share landing points. A landing station may provide power to subsea amplifiers and repeaters, as well. A cable termination station (which may or may not be the same as the landing station) provides the point at which the subsea cable connects with the high capacity, terrestrial, backhaul system, typically near an area of high communications demand such as major metropolitan areas.

[62] Fibertronics, U.S. Patent No. 4,278,835

The first subsea fiber optic cable, TAT-8, running between the United States (AT&T), the United Kingdom (British Telecom), and France (France Telecom), was laid in 1988. It was capable of carrying 280 megabits per second (Mbps), the equivalent of 40,000 telephone circuits.

As of 2020, roughly 400 subsea optical fiber cables are operational. The highest capacity subsea fiber optic cables operate at more than 100 terabytes per second (Tbps), more than 10 million times the speed of the typical home internet connection and the equivalent of carrying 45 million high definition videos simultaneously. The Marea cable, connecting the United States (Virginia Beach, VA) and Bilbao, Spain, has a design capacity of 160Tbps but has demonstrated the ability to run at up to 200Tbps.

Recent technology developments include capacity-enhancing spatial digital multiplexing (SDM) and twisted light spirals. Google Global Networking has recently reported adapting the use of existing subsea fiber optic cable technology to detect and provide early warnings for earthquakes and tsunamis.

A2.2 Subsea Communications Infrastructure - Investment Outlook

The Latin American/Caribbean region hosts and has under construction a total of 68 cable systems and 217 landing stations (*Figure 48*).

The global subsea fiber optic cable market is approximately $14 billion with a projected growth rate of 13 percent through 2025[63]. Today, the U.S. and China represent a combined 42 percent of the global market, with the Latin American/Caribbean market estimated to represent a 10 percent share, or about $1.4 billion. Both Brazil and Argentina host subsea fiber optic cables. Paraguay is currently developing its first link to a subsea fiber optic cable network. U.S. companies are well-represented among cable developers, operators, and technology providers in the three countries today.

While historically, telephony and telecommunications companies owned subsea fiber optic cable systems, increasingly, content providers such as Amazon, Facebook, Google, and Microsoft are emerging as owners and co-developers of new cables. In addition to the numerous ongoing subsea fiber optic cable projects in Brazil, Argentina, and Paraguay, this creates unique opportunities for U.S. companies to align with U.S. content providers for new cable development in the Latin American/Caribbean region and across the globe.

[63] ReportLinker

Figure 48: Latin American/Caribbean Region Subsea Fiber Optic Cable Map[64]

[64] Telegeography

A2.3 Argentina

Argentina has subsea international fiber optic cable connections both directly and via Brazil. The country currently hosts one subsea cable-landing site. The Las Toninas landing station, in the province of Buenos Aires, provides connections to seven international subsea cables (*Table 18*). Argentina also has domestic subsea fiber optic cable infrastructure, including the 40 km ARSAT Submarine Fiber Optic Cable connecting Cabo Espiritu Santo and Punta Dungeness.

Table 18: International Subsea Fiber Optic Cables Landing at Las Toninas, Argentina[65]

Cable	Operator	Length (km)	Distant Landing	Ready for Service (RFS) Date
Atlantis-2	Telecom Argentina, et al	8,500	Carcavelos, Portugal	2/2000
Bicentario	Telecom Argentina, Antel Uruguay	250	Maldonado, Uruguay	12/2011
Malbec	GlobeNet, Facebook	2,500	Rio de Janeiro, Brazil	Q3/2020
SAm-1	Telxius	25,000	Valparaiso, Chile	3/2001
SAC	Telecom Italia Sparkle, CenturyLink	20,000	Valparaiso, Chile	9/2000
Tannat	Google, Antel Uruguay	2,000	Santos, Brazil	Q1/2018
Unisur	Antel Uruguay, Telxius	265	Maldonado, Uruguay	3/1995

With an RFS date of Q3 2020, the GlobeNet/Facebook Malbec cable will link São Paulo and Rio de Janeiro to Buenos Aires, with a branching unit reaching Port Alegre, Brazil. This cable incorporates recent enhancements to fiber optic technology, including Spatial Division Multiplexing (SDM). These technologies will allow Malbec to deliver double the current capacity to Argentina and provide a high-capacity pathway between Argentina and the United States.

A2.4 Brazil

Brazil serves as a regional hub for international subsea fiber optic cable landings, as well as supporting domestic-service subsea cables. The country's principal international cable landing stations are at Fortaleza, Rio de Janeiro, Santos (São Paulo), and Praia Grande, with two international cable linkages established at the Salvador landing station, as well. The country hosts

[65] SubmarineCableMap.com

eleven high capacity, internationally connected subsea fiber optic cables, with another two in development (*Table 19*).

Table 19: International Subsea Fiber Optic Cables Landing in Brazil[66]

Cable	Operator	Length (km)	Landing Point(s)	Distant Landing	RFS Date
EllaLink	EllaLink Group	6,200	Praia Grande & Fortaleza	Sines, Portugal	2021 (under construction)
Malbec	GlobeNet/ Facebook	2,500	Praia Grande & Rio de Janeiro	Las Toninas, Argentina	Q3 2020 (under construction)
Seabras-1	Seaborn Networks	10,800	Praia Grande	Wall Township, NJ, USA	9/2017
América Móvil AMX-1	América Móvil	17,800	Rio de Janeiro, Salvador & Fortaleza	Baranquilla, Colombia San Juan, Puerto Rico	2014
BRUSA	Telxius	11,000	Rio de Janeiro & Fortaleza	Virginia Beach, VA, USA	8/2018
GlobeNet	GlobeNet	23,500	Rio de Janeiro & Fortaleza	Banaraquilla, Colombia and Tuckerton, NJ, USA	10/2000
SAm-1	Telxius	25,000	Rio de Janeiro, Santos & Fortaleza	Valparaiso, Chile	3/2001
SAC	Telecom Italia Sparkle, CenturyLink	20,000	Rio de Janeiro & Fortaleza	Valparaiso, Chile	9/2000
Americas – II	Embratel and 11 others	8,373	Fortaleza	Camuri, Venezuela, Willemstead, Curaçao	8/2000
Atlantis – 2	Embratel and 15 others	8,500	Fortaleza	Carcavelos, Portugal, Praia, Cape Verde	2/2000
Monet	Angola Cables, Algar Telecom, Google and Antel Uruguay (via Tannat cable)	10,556	Fortaleza & Santos	Boca Raton, FL, USA	12/2017
SACS	Angola Cables	6,165	Fortaleza	Sangano, Angola	9/2018
SAIL	Camtel, China Unicorn	5,800	Fortaleza	Kribi, Cameroon	9/2018

[66] SubmarineCableMap.com, Seaborn Networks

Brazil also supports subsea fiber optic cable systems to service domestic needs. Google's cable, Junior, Ready for Service (RFS) third-quarter 2018, runs 390 km between Rio de Janeiro and Santos. The longest domestic line is the Festoon. The Festoon, an Embratel cable, was RFS in 1996 and runs 2,543 km along Brazil's Atlantic coast. It connects not only the international landing stations but also the following landing points for the domestic Brazilian market:

- Atafona (Rio de Janeiro);
- Macaé (Rio de Janeiro);
- Vitória (Espírito Santo);
- São Mateus (Espírito Santo);
- Porto Seguro (Bahia);
- Ilheus (Bahia);
- Sitio (near Conde) (Paraíba);
- Aracajú (Sergipe);
- Maceió (Alagoas);
- Recife (Pernambuco);
- João Passoa (Paraíba); and
- Natal (Rio Grande do Norte).

International cable projects in development include the EllaLink cable to Portugal and a cable between Brazil and Argentina. The GlobeNet/Facebook Malbec cable will link São Paulo and Rio de Janeiro to Buenos Aires, with a branching unit reaching Port Alegre, Brazil. It will use recent enhancements to fiber optic technology, including Spatial Division Multiplexing (SDM), to deliver double the current capacity to Argentina and provide a high-capacity pathway between Argentina and the United States.

Domestic projects include an extension of the Seabras-1 cable to Recife to service the state of Pernambuco, as well as surrounding states in northeastern Brazil.

A2.5 Paraguay

Paraguay is landlocked, hence it has no direct ocean access and no subsea fiber optic cables or landing stations of its own. The Paraguayan Ministry of Technologies of Information and Communication (MITIC) has recently undertaken a first subsea-related cable project.

The project will develop a high-capacity fiber optic cable to link Asunción, Paraguay with the submarine cable system at the Las Toninas landing station in Argentina. The project will create internet protocol (IP) transit managed by the government of Paraguay. Several options exist at Las Toninas for international subsea connections, including the ARSAT, Telefonica, Silica Networks, and Telecom Argentina cables. The project involves a 20-year service contract, the rental of dark optical fiber (cable installed and operable but not yet in use) to one of the operators having fiber deployed in the geographic section of interest, and the purchase of equipment necessary to illuminate this fiber.

A3 SATELLITES

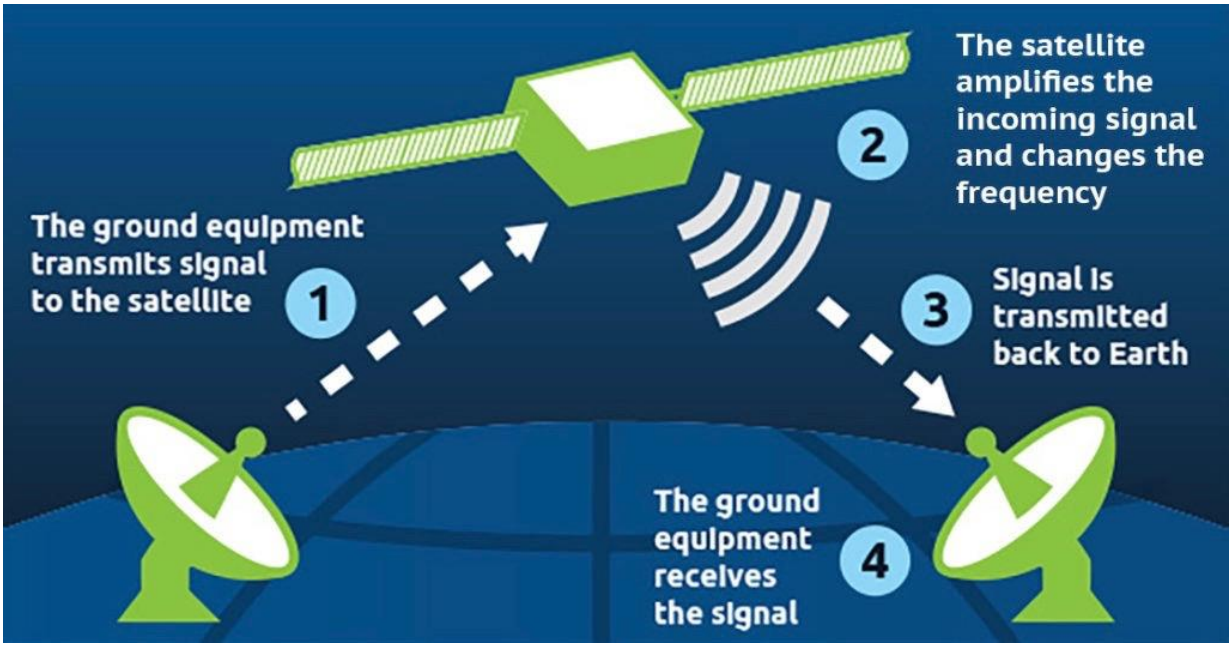
A3.1 Sector Overview

While much of communications technology resides on land, the modern world also uses space to enhance the ability to communicate globally. Eighty-one countries and country cooperative groups have orbiting satellites as of 2020. As of March 2020, there were 5,774 satellites in space, with 2019 witnessing the launch of 580 new vehicles, the largest number in a year to date.[67] Of this number, about 2,100 are currently active, and 45 percent are communications satellites.[68]

Satellites communicate by using radio waves to send signals to antennae on the earth. The antennae capture the signals and process the information contained therein. Satellite communications require four steps (*Figure 49*):

- An uplink earth station (or other ground equipment) transmits the desired signal to the satellite;
- The satellite amplifies the incoming signal and changes its frequency;
- The satellite transmits the signal back to earth; and
- Ground equipment receives the signal.

Figure 49: How a Satellite Works[69]



[67] United Nations Office for Outer Space Affairs (UNOOSA)
[68] Satellite Industry Association
[69] Intelsat

Commercial communications satellites segment into three categories:

- **Fixed satellites (FS)** – use ground equipment at set locations to receive and transmit satellite signals.
- **Mobile satellites (MS)** – use a variety of transportable receiver and transmitter equipment for land mobile, maritime and aeronautical applications.
- **Broadcast satellites (BS)** – incorporate high transmission power for reception using very small ground equipment primarily for direct-to-consumer television and broadband applications.

Commercial satellite services principally use three radio frequency bands:

- **C-band** – 4-8 GHz providing lower transmission power over wide geographic areas; generally requires larger ground equipment for signal reception.
- **Ku-band** – 12-18 GHz with higher transmission power over smaller geographic areas; received with smaller ground equipment.
- **L-band** – 1-2 GHz for mobile applications (e.g., maritime and aeronautics) received with a variety of ground equipment.

with a fourth of emerging interest:

- **Ka-band** – offering a larger frequency range, can transmit different signals at the same time to multiple geographic areas. Economically efficient at high data rates.

Finally, satellites also segment by the nature of their orbits:

- **Geostationary (GEO)** – an earth-orbiting satellite, placed at an altitude of approximately 22,300 miles directly over the equator, revolving in the same direction the earth rotates. At this altitude, one orbit takes 24 hours.
- **Low-Earth (LEO)** – placed at several hundred miles above the earth, significantly reducing the delay created as the signal travels between earth and the satellite, with an orbital period of 10 to 40 minutes. LEOs are advantageous for global mobile telephone services, where signal delays during two-way communications are disruptive and confusing. Unlike GEO satellites, LEOs do not remain in a fixed position in the sky relative to earth. As a result, these satellites must have the capability to hand off the signal to another satellite or a local ground-based gateway once it passes beyond direct view.
- **Medium-Earth (MEO)** – placed at an altitude between LEO and GEO, i.e., between 1,243 and 22,236 miles, above the earth (typically 12,252 miles) with an orbital period of 2 to 24 hours (12 hours typical). Typical MEO uses include navigation (e.g., GPS).

Small satellites weigh less than 500 kilograms (kg), with medium running from 500 to 100kg, and large satellites more than 1,000 kg. The largest satellite is the International Space Station. An "average" satellite is about the size of a small car. Clusters of satellites allow several smaller, less costly satellites to provide a similar function to a larger vehicle.

The physical elements of a satellite include:

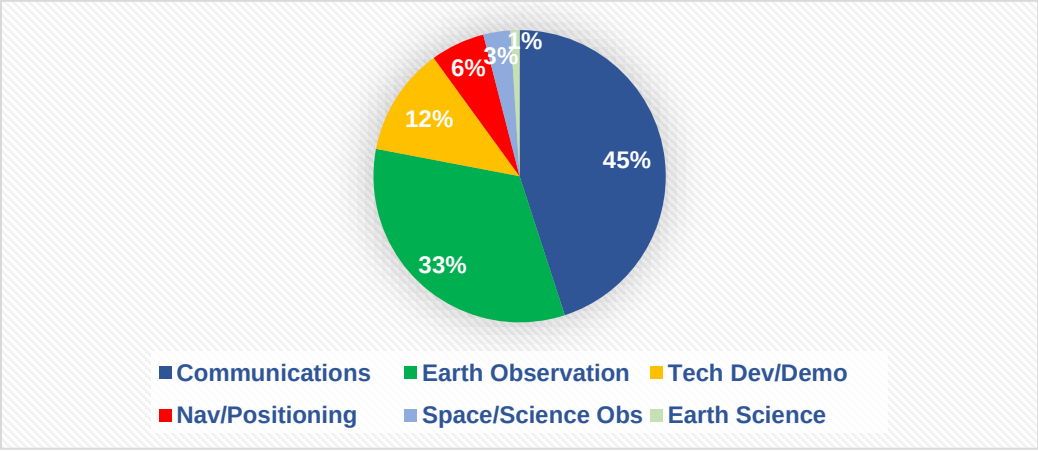
- **Communication payload** – typically composed of transponders, antennae, and switching.
- **Engines** – to bring the satellite to its desired orbit.
- **Station keeping tracking and stabilization system** – to keep the satellite in the correct orbit, its antennae pointed in the proper direction, and power system toward the sun.
- **Power subsystem** – to power the satellite systems. The power subsystem is typically primarily solar cells with batteries to maintain power during any solar eclipse.
- **Command and control subsystem** – to maintain communications with ground control stations. The ground control earth stations monitor satellite performance and control functionality during various life-cycle phases.

Several Latin American/Caribbean region countries operate satellites, including:

- Brazil (since 1985);
- Mexico (1985);
- Argentina (1990);
- Bermuda (2000);
- Colombia (2007);
- Venezuela (2008);
- Chile (2011);
- Ecuador (2013);
- Peru (2013);
- Bolivia (2013);
- Costa Rica (2018); and
- Guatemala (2020).

Satellites are used for a variety of purposes (*Figure 50*). Today, 45 percent of satellites are for communications, whose share has been increasing.

Figure 50: Share of Satellites by Use[70]



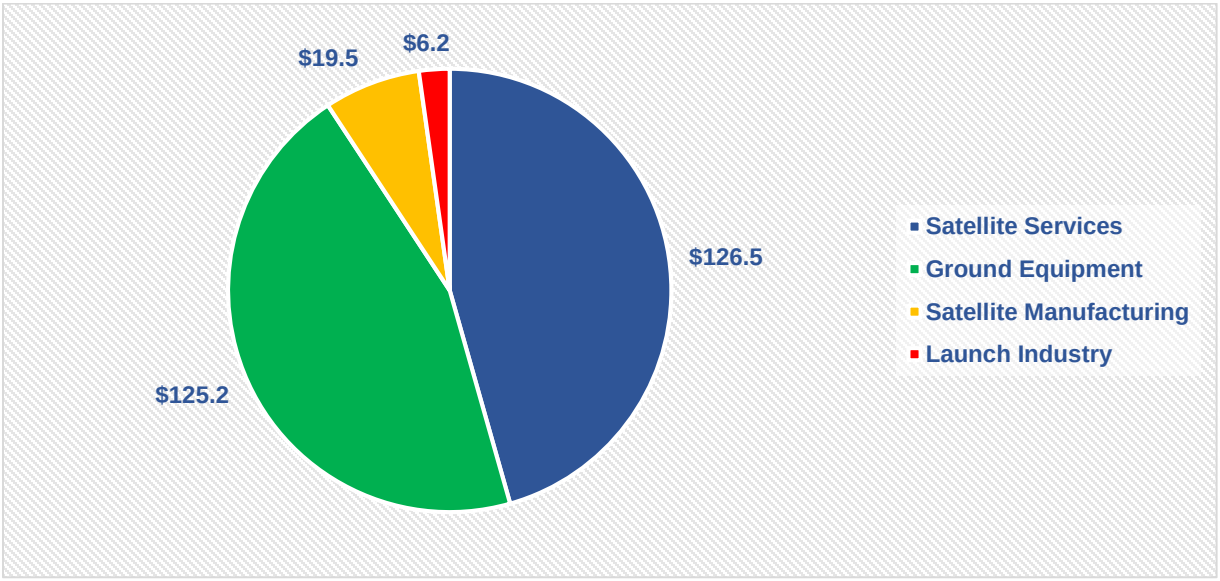
[70] UNOOSA

A3.2 Satellites - Investment Outlook

The overall global satellite market is approximately $277 billion, of which satellite services and ground equipment comprise the majority (*Figure 51*). Overall five-year growth will range from two to four percent, with satellite manufacturing and the launch industry experiencing double-digit growth. In contrast, ground equipment will grow more slowly, and services sector revenues may be flat to declining due to competition. The Latin American/Caribbean region represents less than five percent of the global satellite market today.

The global small satellite market, the most rapidly growing communications satellite segment, was valued at over $4 billion in 2018, with expected growth of over 20 percent (CAGR) through 2026.[71] Demand drivers for small satellites include the expansion of Internet of Things (IoT) industrial technologies and the associated growth of 5G communication networks.

Figure 51: Global Satellite Industry Segmentation of Revenues, 2018 ($MM)[72]



Three primary types of communication services are provided by small satellites, both to commercial and government sectors:

- ***Telecommunications*** – telephone calls and services provided to telephone companies, along with wireless, mobile, and cellular network providers;
- ***Broadcasting*** – radio and television services including network and cable programming delivered to local stations; and
- ***Data communications –*** including internet communications.

[71] Fortune Business Insights
[72] Satellite Industry Association

LEO satellites are beginning to pose competition to subsea fiber optic cables as a means of transferring large amounts of data. For example, Elon Musk's Starlink, a part of the satellite launch company, SpaceX, is developing a constellation of LEO satellites that will deliver high-speed broadband internet to locations where access has been unreliable, expensive, or completely unavailable. Starlink is targeting service in the Northern U.S. and Canada in 2020, with rapid expansion to near-global coverage of the populated world by 2021. Starlink is an extraterrestrial broadband network, which, in the future, may include extraterrestrial data centers as part of its platform. Information traveling through satellites transmits 47 percent faster than via standard subsea fiber optic cables. Competitors to SpaceX/Starlink include LeoSat, One Web, and Telesat. This technology may be of particular interest to countries, such as Paraguay, which do not have ocean access and have remote populations requiring interconnectivity.

A3.3 Argentina

Argentina currently has 22 satellites in orbit (*Table 20*). The NuSat class comprises earth observational satellites, as is the first SaoCom satellite (with another expected to be launched soon). The CubeBug group includes primarily technology development and demonstration satellites. The ARSAT group comprises communication satellites. As typical satellite lifetimes are in the range of 10 to 15 years for GEO and about five years for LEO satellites, those launched before 2010 are likely not operational.

In 2006, Argentina created, by federal law, ARSAT SA, a company given the right to explore the 81 degrees West orbital slot and mandated to build in the country and operate one or more communications satellites. ARSAT launched its first satellite, ARSAT-1, in October of 2014, from French Guiana. ARSAT-1 is a geostationary Ku band satellite with a payload of 350kg. ARSAT-1 is expected to remain operational through 2033.

ARSAT-2, also a geostationary satellite, built by the Argentine company, INVAP, was launched from French Guiana during September 2015. Structurally and mechanically, it is a copy of ARSAT-1 except for payload, necessitating rearrangement of the antennae configuration. ARSAT-2 includes both Ku and C band sections.

ARSAT is currently developing ARSAT Second Generation-1 (ARSAT SG-1, formerly known as ARSAT-3). Like its predecessors, this satellite will orbit at the 81 degrees West longitude geostationary slot. New technology updates, however, will include high-throughput Ka band capability (12 Ku-band and 8 Ka-band operative transponders). Argentina initiated this project in 2015, but a lack of funding due to insufficient capacity utilization of ARSAT-2 stalled the project. The Argentine administration elected in December 2019 has agreed to finance the project, with ARSAT SG-1 to be launched in 2023. Its operative lifetime will be 15 years.

Table 20: Argentina Satellites in Orbit, 2020[73]

Name	NORAD ID	International Code	Launch Date
NUSAT-8 (MARIE)	45018	2020-003C	January 15, 2020
NUSAT-7 (SOPHIE)	45017	2020-003B	January 15, 2020
SAOCOM 1-A	43641	2018-076A	October 8, 2018
NUSAT 5	43204	2018-015K	February 2, 2018
NUSAT 4	43195	2018-015D	February 2, 2018
NUSAT 3	42760	2017-034C	June 15, 2017
NUSAT 2 (BATATA)	41558	2016-033C	May 30, 2016
NUSAT 1 (FRESCO)	41557	2016-033B	May 30, 2016
ARSAT 2	40941	2015-054B	September 30, 2015
ARSAT 1	40272	2014-062B	October 16, 2014
BUGSAT 1	40014	2014-033E	June 19, 2014
CUBEBUG 2	39440	2013-066AA	November 21, 2013
CUBEBUG 1	39153	2013-018D	April 26, 2013
SAC-D (AQUARIUS)	37673	2011-024A	June 10, 2011
PENHUESAT 1	29712	2007-001D	January 10, 2007
LATINSAT A	27612	2002-058H	December 20, 2002
LATINSAT B	27606	2002-058B	December 20, 2002
SAC C	26620	2000-075B	November 21, 2000
NAHUEL 1A	24714	1997-002B	January 30, 1997
OSCAR 19 (LUSAT)	20442	1990-005G	January 22, 1990
NAHUEL I1 (ANIKC1)	15642	1985-028B	April 12, 1985
NAHUEL I2 (ANIKC2)	14133	1983-0559B	June 18, 1983

A3.4 Brazil

Brazil currently has seventeen satellites in orbit (*Table 21*). Brazil's GEO satellites orbit at the 70 degrees West longitude geostationary slot. The BrazilSat and StarOne families are communications satellites operated by the former state-owned Embratel (the former long-distance arm of Telebras), which is now owned by América Móvil of Mexico. Nanosat is the first CubeSat science and technology development project. The National Institute for Space Research, a research unit of MITIC, operates the SCD satellites.

Through MITIC and Telebras, Brazil is developing a system of geostationary satellites for strategic and defense communications (SSGDC). The first such satellite, SGDC-1, was launched in 2017, with an expected lifespan of 18 years. SGDC-1, also Brazil's most recent satellite launch, is a telecommunications satellite offering military and civilian utility including delivery of premium internet services across eight Brazilian states: Rio de Janeiro, Pernambuco, São Paulo, Minas Gerais, Rio Grande do Sul, Amazonas, Paraná, and Federal District. The satellite system will

[73] N2YO.com

feature both military (X-band) and civilian (Ka-band) capabilities. The second in the SGDC satellite family, SGDC-2, is currently under study.

A 2019 cabinet-level meeting between Brazil and the United States led to an agreement between NASA and the Brazilian Space Agency to launch a jointly developed research satellite shortly. The United States and Brazil are strengthening cooperation on defense issues, including research and development, technology security, and the acquisition and development of products and services.

Table 21: Brazil Satellites in Orbit, 2020[74]

Name	NORAD ID	International Code	Launch Date
SGDC	42692	2017-023B	May 4, 2017
STARONE D1	41904	2017-082B	December 21, 2016
STAR ONE C4	40733	2015-034B	July 15, 2015
NANOSAT C BR1	40024	2014-033Q	June 19, 2014
STARONE C3	38991	2012-062A	November 10, 2012
STAR ONE C2	32768	2008-018B	April 18, 2008
STAR ONE C1	32293	2007-056A	November 14, 2007
BRAZILSAT B4	26469	2000-046A	August 17, 2000
SACI 1	25941	1999-057B	October 14, 1999
SCD 2	25504	1998-060A	October 23, 1998
BRAZILSAT B3	25152	1998-006A	February 4, 1998
BRAZILSAT B2	23536	1995-016A	March 28, 1995
BRAZILSAT B1	23199	1994-049A	August 10, 1994
SCD 1	22490	1993-009B	February 9, 1993
OSCAR 17 (DOVE)	20440	1990-005E	January 22, 1990
BRAZILSAT 2	16650	1986-026B	March 28, 1986
BRAZILSAT 1	15561	1985-015B	February 8, 1985

A3.5 Paraguay

At present, Paraguay has no communications satellites of its own. Paraguay founded a space agency, the Agencia Espacial de Paraguay (AEP), in 2014. The agency's focus is on training personnel and developing the interest of children in space and astronomy. A key challenge facing the agency is the development of talent, intended to be accomplished through agreements with foreign universities and space agencies. Paraguay had plans to launch its first satellite in 2021, which appear to be delayed, a process expected to require a minimum of two to three years. Various Paraguayan research centers have begun a collaboration to develop a CubeSat miniature satellite for forest/property line mapping.

[74] N2YO.com

A4 DATA CENTERS and CLOUD COMPUTING

A4.1 Sector Overview

Data centers and cloud computing are closely interrelated. Data centers provide storage for large amounts of digital information. Cloud computing, simply, is accessing and storing information and programs that do not reside on the computer a user is accessing, but rather via the internet, with the data/programs stored remotely in a data center.

A4.1.1 Data Centers

Data centers store and assist in the retrieval and processing of large amounts of critical information. Frequently, a data center houses servers/data storage for a specific organization, though multiple customers share many. A data center includes:

- The building/real estate housing storage;
- Storage hardware (servers);
- Server racks and cabinets;
- Power and operational backup systems;
- Environmental controls, especially cooling;
- Cyber and physical security; and
- Anything else deemed necessary to keep the servers running.

A data center may be as simple as a single server or as complex as hundreds of thousands of servers (*Figure 52*). The average data center includes tens of thousands of servers and occupies about 100,000 square feet of space. The largest global data centers are in the range of three to seven million square feet. Most data centers, especially large-scale facilities, are sited to avoid natural disasters, thus minimizing downtime risk. Power and cooling are large operational cost contributors, as well as limits to data center scale.

Figure 52: Data Center Exterior and Interior[75]

[75] Amazon Web Services, JAYCor International

Data centers segment by:

- Type – nature of operations;
- Tier (I-IV) – uptime/downtime/redundancy;
- Density – low, medium, high, and extreme;
- Vertical served – e.g., government, telecom and IT, banking and finance, healthcare; and
- Nature of infrastructure – types of electrical, mechanical, and IT systems incorporated.

Data centers types include:

1. **Hyperscale** – typically owned and operated by the company it supports. Hyperscale data centers offer a portfolio of scalable applications and storage to third-party individual and corporate customers. These data centers are typically high-square-footage, high-server-count locations distinguished by an ultra-high-speed, high fiber-count, fiber-optic network. Participants in this sector include AWS (an Amazon subsidiary), Microsoft, Google, and Apple.

2. **Colocation/Wholesale Colocation** – these data centers are typically single-owner sites, where the owner sells or leases space, power, and cooling to other enterprises or hyperscale customers in a specific location. Typical colocation data centers typically service hundreds to thousands of customers. In addition to basic data center capabilities, these facilities often provide technical guidance and, importantly, interconnection services to Software as a Service (SaaS – e.g., Salesforce) and Platform as a Service (PaaS – e.g., Azure) to assist their customers in scaling their businesses with low cost and complexity. Wholesale Colocation data centers typically do not offer Interconnection Services. They tend to service fewer customers than average, as they typically focus on location-specific infrastructure provision for sophisticated enterprise and hyperscale clients.

3. **Enterprise** – an enterprise data center is owned and operated by the company/entity it supports, often at the location of existing company operations. Owners may divide enterprise data centers to host the needs of various businesses within the company's portfolio. Mechanical and electrical services are often outsourced, but the company typically runs the white space (data center operations) itself. Enterprise data centers usually comprise at least ten server cabinets (several hundred servers) but may be much larger.

4. **Telecom** – a telecom data center is owned and operated by a telecommunications or telecom services provider (e.g., AT&T, Verizon, *et al*) and requires unusually high levels of connectivity and reliability. Telecom data centers are responsible for driving content delivery, mobile services, and cloud services. They may be "lights out" (i.e., physically or geographically isolated) to minimize environmental and human contact and ensure uptime.

5. **Edge** – these are the newest type of data center and are in the early stages of development. Edge data centers will support Internet of Things (IoT), autonomous vehicles, and other data-intense applications for which content placement close to the user is desirable. Likely to be powered by 5G communications networks to support high data transport requirements and minimize latency, their development will require considerable optical fiber hardware and fiber optics installations. Key characteristics include:

- *Local* – placed near areas served but managed remotely;
- *Small* – same components as a traditional data center but a smaller-than-typical footprint;
- *Fractional* – one of many in a larger, complex network that includes a central enterprise or hyperscale data center; and
- *Mission-critical* – bringing computation and data storage closer to the location where required, improving response times, saving bandwidth, and minimizing latency.

Also, data centers are typically segmented by tiers, defining their annual uptime availability, maximum downtime, redundancy of power paths, and ability to withstand force majeure events (*Table 22*).

Table 22: Data Center Tiers[76]

Tier	User Group	Uptime (%)	Annual Downtime (hours)	Power Outage Protection (hours)
1	Small Businesses	99.671	28.8	No redundancy
2	Medium-size Businesses	99.749	22.0	Partial redundancy
3	Large Businesses	99.962	1.6	72
4	Enterprise Corporations	99.995	0.4	96

Technology is changing rapidly in this sector with the development of artificial intelligence (AI), edge and serverless computing, and SaaS (software-as-a-service/online subscription models), all of which move away from historic data centralization. Satellite operator Starlink (part of Elon Musk's SpaceX), which is launching hundreds of Low Earth Orbit (LEO) satellites to provide global broadband coverage (especially those too difficult to reach locations), even envisions the addition of extraterrestrial data centers to support its extraterrestrial broadband network.

A4.1.2 Cloud Computing

Cloud computing, in simplest terms, is storing and accessing data and programs over the internet instead of on one's own computer hard drive. More broadly, Cloud computing is a process of delivering and enabling scalable, expandable, almost perfectly elastic software services using internet technologies. Typically provided through a third-party vendor with its own data centers, cloud computing is a means of delivering Software as a Service (SaaS) on a pay-per-use or pay-per-time period basis. Cloud computing provides self-service capabilities with scalable features to users, allowing increased capacity upon requirement. Typical service offerings of cloud computing providers include Infrastructure (IaaS), Platform (PaaS), and Software (SaaS) as a Service, as well as Backend as a Service (BaaS), which is similar to SaaS except directed toward developers,

[76] ComRent/The Aberdeen Group

whereas SaaS is directed toward users. In each approach, the user company manages certain functions, and the Cloud Services provider handles others (*Table 23*).

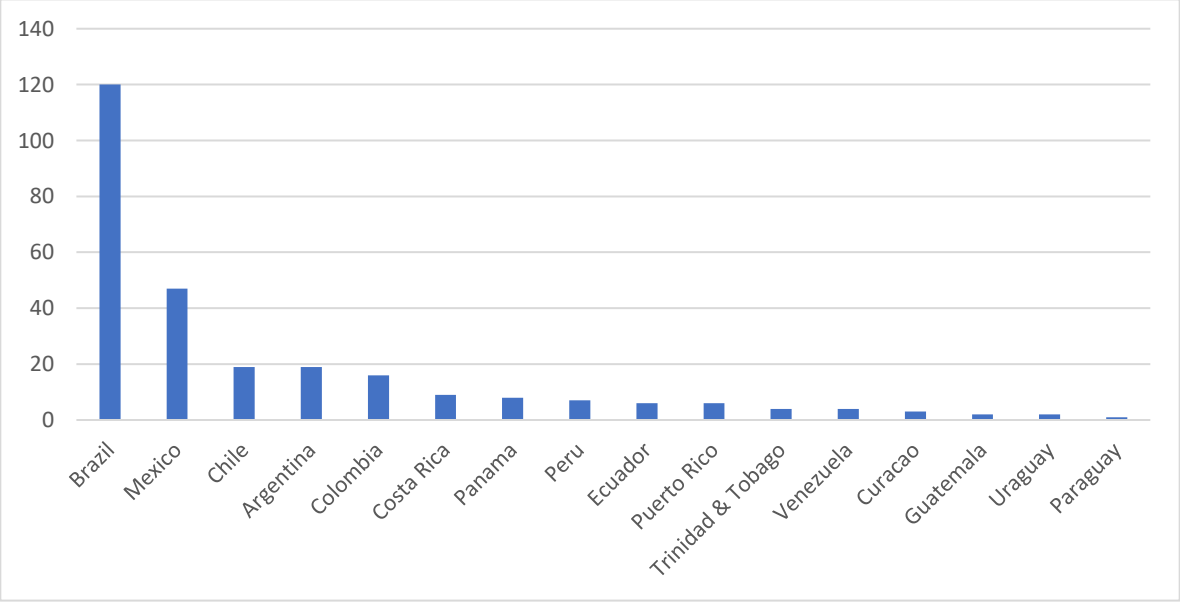
Table 23: Cloud Computing Activities by "As a Service" Type[77]

Separation of Responsibilities – "As a Service " (aaS) Formats			
On Premises	Infrastructure (IaaS)	Platform (PaaS)	Software (SaaS)
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

User Manages Service Provider Manages

Data center (and cloud computing) presence varies widely within countries in the Latin American/ Caribbean region (*Figure 53*).

Figure 53: Number of Latin American/Caribbean Region Data Centers by Country[78]



[77] Assist Software
[78] Cloudscene and Datacentermap

A4.2 Data Centers / Cloud Computing Investment Outlook

The global data center business is $135 billion globally, with projected compound average annual growth rate (CAGR) estimates ranging from five to ten percent through 2023. The Latin American/Caribbean data center business is approximately five percent of the world total and projected to grow slightly faster than the global rate. Demand for new regional data centers is driven by government initiatives toward modernization/infrastructure development and employment, along with the growth of private enterprise.

Several large U.S. players, including AWS (operating in São Paulo since 2011 and currently planning a large expansion there, as well as in Argentina), Microsoft, and IBM (operating in São Paulo since 2005) are present in Brazil. Equinix, a U.S.-headquartered global player, has data centers in São Paulo and Rio de Janeiro.

The global market for cloud computing is approximately $15 billion, with a CAGR of 19 percent through 2027.[79] Today, the United States is the largest cloud computing market, representing about one-third of global demand. The Latin American/Caribbean region represents about 10 percent of the global market currently. This region is projected to grow at a CAGR of over 25 percent from 2020 to 2027 (not accounting for likely development lags resulting from the 2020 COVID-19 global pandemic).

Several large U.S. cloud-computing players, including Cisco, Hewlett Packard, IBM, and Microsoft (Azure) are already operationally present in Brazil, and several have offices in Buenos Aires.

A4.3 Argentina

Argentina hosts several co-location data centers, primarily in the environs of Buenos Aires, but also in Cordoba. Cloud computing capabilities are provided in Argentina by IBM, Microsoft Azure, and Oracle. Telecommunications providers, including Claro, Movistar, and government-owned ARSAT, also offer cloud services. ARSAT has constructed a state-of-the-art data center to facilitate cloud computing for consumers. As of late 2019, it was the only Tier III data center in Argentina.

In 2019, Argentina enacted the "Knowledge Economy Law," which provides incentives for technology companies serving the following ICT markets:

- Software;
- Computer and digital services;
- Audiovisual production and post-production;
- Geological and prospecting services and others related to electronics and communications;
- Professional services as long as they are exported;
- Nanotechnology and nanoscience;
- Artificial intelligence;

[79] Report Linker

- Robotic and industrial internet;
- The Internet of Things (IoT); and
- Augmented and virtual reality.

The Knowledge Economy Law offers prospective investors the following incentives:

- ***Fiscal stability***: as of the moment of the registration and for the term of validity of the Regime. This benefit also may be extended to provincial and municipal taxes, as long as such jurisdictions adhere to the law.
- ***Income tax***: the general corporate tax rate is reduced to 15 percent, to the extent that the beneficiaries maintain their payroll. Beneficiaries will be allowed to deduct a tax credit derived from any payment or withholding of foreign taxes if the taxed income constitutes an Argentine source of income.
- ***Value-added tax (VAT)***: beneficiaries will not be subject to any withholding and/or collection VAT regimes.
- ***Employer social security contributions***: beneficiaries will be able to fully deduct from their employer social security contributions, in relation to each employee, an amount equal to the maximum established in article 4 of Decree 814/2001 (which currently is 17,509.20 pesos).
- ***Additional benefit***: beneficiaries will be able to obtain a one-time transferrable tax credit bond, which can be used for paying advances or balances of income tax or VAT. The bond is equal to 1.6 times the amount of the employer's social security contributions that the beneficiary did not pay due to the benefit mentioned in the above paragraph.

Following the enactment of the Knowledge Economy Law, AWS announced the purchase of three land parcels proximal to major highways near Bahia Blanca for the anticipated construction of three data centers, currently codenamed Tango Sur, Tango Central, and Tango Norte. The government has promised AWS the 15 percent tax rate, as well as favorable energy and labor rates, incenting the selection of Argentina over Chile, where tax rates were expected to be higher.

A4.4 Brazil

Brazil hosts over 100 data centers at 41 locations, supported by more than ten different providers. There are at least 40 co-location facilities, 38 cloud nodes, and ten disaster recovery/business continuity (DRBC) sites.[80]

By 2015, approximately 500,000 square feet of data centers existed in Brazil. Early data centers in Brazil included Santander's Campinas site, serving its financial operations across the country with one of Brazil's largest data centers. Other early participants included telecommunications, data center, and cloud computing company, Ascenty, which today owns some of the largest Brazilian carrier-neutral data centers. Ascenty now hosts 22 data centers spanning the São Paulo metro area, Rio de Janeiro, and Fortaleza (Ceará state), as well as sites in Chile and Mexico.

[80] Datacenters.com

Large U.S. data center and cloud computing companies are also present in Brazil, primarily in the São Paulo metropolitan area. IBM hosts a data center near São Paulo and has announced plans for a pan-Brazil cloud computing expansion, including artificial intelligence (AI) systems support. Microsoft has operated an Azure data center near São Paulo since 2014. AWS announced in early 2020 its plans to expand its data center presence in São Paulo.

Digital Colony Management, a digital infrastructure investment firm, announced in the second quarter of 2020, its establishment of Scala Data Centers SA, a hyperscale data center platform via the acquisition of assets from UOL Diveo. Scala will be one of the largest data center platforms in Brazil and expects to continue growth via both organic development and acquisition.

Brazilian governmental entities are also engaged in data center and cloud computing growth. A multi-agency initiative seeks to implement the Strategy for e-Government 2020, whose goal is to optimize the infrastructure of 30 federal data centers, as well as shift the work of at least 30 government agencies to the cloud. Data center projects also exist in some Brazilian states; for example, a program of private cloud deployment with public cloud service contracting is in process in Rio Grande do Sul.

The Brazilian General Data Protection Law (LGPD) was passed by the National Congress of Brazil on August 14, 2018, and takes effect on August 15, 2020. The LGPD creates a legal framework for the use of personal data of individuals in Brazil, regardless of where the data processor is located. The European Union's General Data Protection Regulation (GDPR) serves as the model. Like GDPR, the LGPD has far-reaching consequences for data processing activities in and outside of Brazil. The LPGD is expected to increase cloud and data center services adoption.

Most data center investment in Brazil is likely to be greenfield, with several providers having land for expansion at existing sites. São Paulo and Rio de Janeiro will continue to be preferred sites for new capacity. The 2020 global COVID-19 pandemic has temporarily slowed the construction of several new facilities.

A4.5 Paraguay

In Paraguay, the data center and cloud computing industries are young and developing. IPXON, which hosts a variety of data centers in Latin America and the United States, operates a small co-location data center in Asunción, serving a limited base. Several non-Paraguayan firms, mostly U.S. - and European-based, but with at least one Argentine provider, offer cloud services.

A key initiative of the government is the creation of a government data center by 2024. The Ministry of Technologies of Information and Communication (MITIC) is overseeing the planning and development of this data center, which will include: a government/private cloud service; an Internet Exchange Point (IXP); and a Network Operations Center (NOC)

Implementation will follow a modular approach, resulting in a Tier III facility, with 99.982 percent availability and no more than 1.57 hours of annual downtime.

A5 SMART CITIES and e-GOVERNMENT

A5.1 Sector Overview

A smart city is a municipality incorporating information and communications technologies (ICT) to improve efficiency, quality, and urban services performance. The ICT tools aid in reducing resource consumption, waste, and overall costs, as well as improving service quality, responsiveness, and transparency. Frequently, ICT smart-city tools also provide direct service access, and government and community participation to residents.

Typically, more than half of smart-city services are delivered through the public sector, smart cities and e-government are closely related. e-Government (short for electronic government) is the use of ICT networks and devices to provide public services to citizens and other persons residing in a country, region, or municipality. e-Government offers opportunities for more direct and convenient citizen access to government overall, government transparency, and direct provision of government services.

A5.1.1 Smart Cities

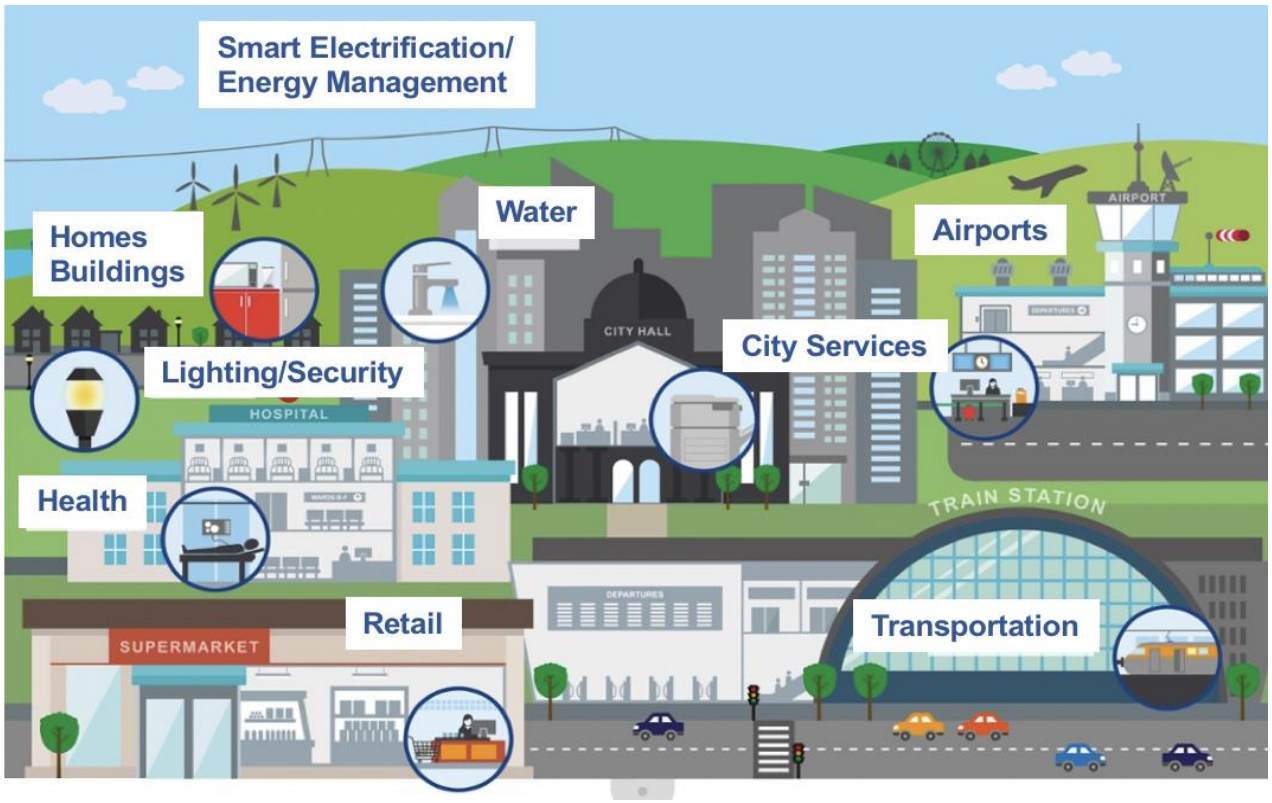
A smart city is a highly digitally connected municipality using information and communications technologies to increase operational efficiency, share information with the public, and improve both the quality of government services and associated citizen welfare. Initiatives typically focus first on infrastructure development such as reliable electric supply, robust IT digitization and connectivity, and efficient public transportation. Efforts surrounding citizen safety and security, public housing, healthcare, education, and traffic and transportation management, as well as government efficiency and transparency, may be added (*Figure 54*).

Today, cities are home to more than half the world's population.[81] The United Nations projects that by 2050, 68 percent of the global population will reside in cities. By 2035, 600 cities will account for approximately 65 percent of global GDP.[82] The continued population migration to cities will require new, personalized, and interactive municipal services, many delivered under the smart cities umbrella. For example, in a pilot of three cities, McKinsey and Company found smart cities tools could produce the following results:

- Reduce fatalities by 8–10 percent;
- Accelerate emergency response times by 20–35 percent;
- Reduce the average commute by 15–20 percent;
- Reduce disease burden by 8–15 percent;
- Reduce greenhouse gas emissions by 10–15 percent; and
- Reduce water consumption per citizen by 25-80 liters per day.

[81] McKinsey & Company
[82] Ibid

Figure 54: Smart City ICT Applications[83]



Numerous entities rank smart cities annually. Top-ranked global smart cities today are located in North America and Western Europe primarily, with Singapore routinely included. In general, wealthier urban areas are faster to transform, though Asia, with large populations of younger citizens, has also rapidly embraced the smart cities concept (*Table 24*).

Lack of sufficient ICT infrastructure has posed challenges to smart city development in certain geographies. In some, such as Asia and the Middle East, initiatives are in development to create new cities that will be smart from the start. Perhaps the most notable "new city" initiative is the development of the new Indonesian capital on the island of Borneo.

In the Latin America Caribbean region, the National Autonomous University of Mexico, with its over 350,000 students, is developing a smart education and supporting local services hub. São Paulo has been at the forefront of adopting smart city practices in Brazil (*Figure 55*). Numerous additional Latin American examples are provided in the project reviews in this Resource Guide.

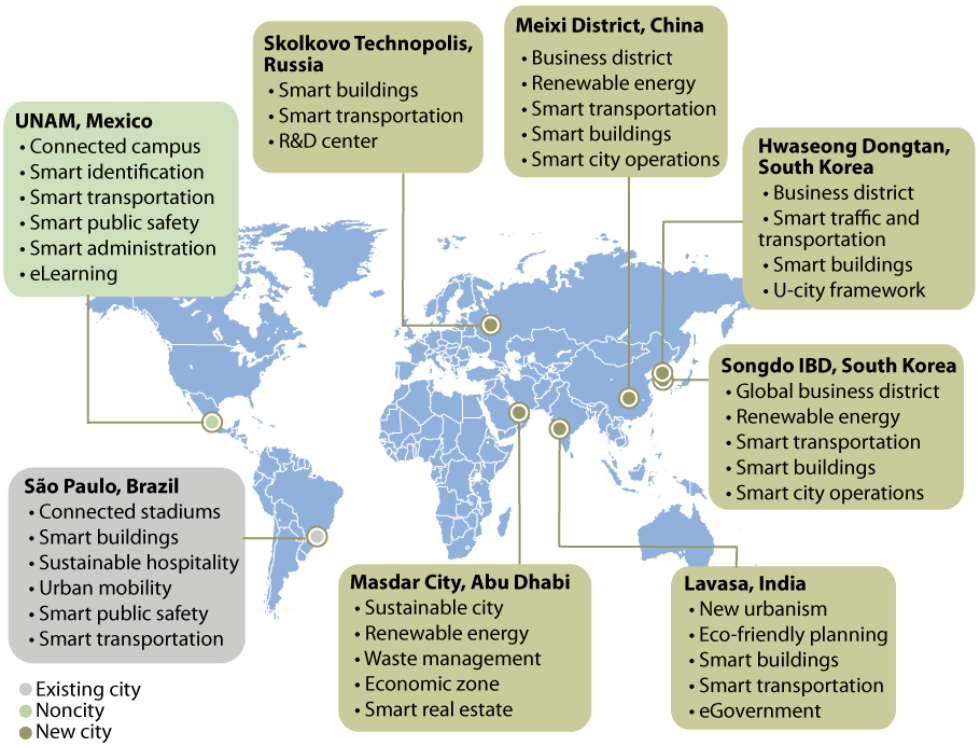
[83] International Electrotechnical Commission

Table 24: Top 40 Global Smart Cities, 2019[84]

Rank	City	Comments
1	London	#1 – Human Capital, #3 – Transportation (behind Shanghai and Beijing – outside top 50), #1 – International Outreach
2	New York	#3 – Human Capital, #1 – Economy, #2 – Urban Planning
3	Amsterdam	#2 – International Outreach
4	Paris	#3 – International Outreach
5	Reykjavik	#1 – Environment
6	Tokyo	#3 – Economy
7	Singapore	#1 – Technology
8	Copenhagen	#3 – Environment
9	Berlin	
10	Vienna	
11	Hong Kong	#2 – Technology
12	Seoul	
13	Stockholm	
14	Oslo	
15	Zurich	#1 – Social Cohesion
16	Los Angeles	#2 – Human Capital, #2 – Economy
17	Chicago	
18	Sydney	
19	Melbourne	
20	San Francisco	#3 – Technology
21	Helsinki	
22	Washington D.C.	
23	Madrid	
24	Boston	
25	Wellington	#2 – Environment
26	Munich	
27	Barcelona	
28	Basel	
29	Taipei	#3 – Social Cohesion, #3 – Governance
30	Berne	#2 – Social Cohesion, #1 – Governance
31	Barcelona	
32	Geneva	#2 – Governance
33	Frankfurt	
34	Hamburg	
35	Auckland	
36	Gothenburg	
37	Dublin	
38	Montreal	
39	Ottawa	
40	Miami	

[84] IESE Cities in Motion Index

Figure 55: Smart City Development Examples Outside North America and Western Europe[85]



Three technology-related layers combine to create a functioning smart city:

1. **Technology base** – including a mass of cell phones and other sensors connected by a high-speed, high-capacity communications network with open data portals;
2. **Applications** – specific programs and digital tools for key functions including economic development, energy, health, housing, mobility, security, waste, water, and engagement/community; and
3. **Public usage** – applications, and the smart city as a whole, rely on broad adoption and resulting changes in citizen behaviors. Applications giving citizens greater transparency and allowing them to optimize their choices generate wide adoption.

More than 80 percent of the population in the Latin American and Caribbean region lives in cities; however, 27 percent of the urban population lives in informal settlements without access to basic services.[86] Digitization is far from uniform and frequently unevenly distributed.

Nonetheless, in the Latin America and Caribbean region, numerous municipalities are already implementing smart city initiatives, and several rank among high and medium performers in the IESE Cities in Motion (Smart Cities) Index of 174 global cities:

[85] Forrester Research
[86] Inter-American Development Bank

- Santiago, Chile (66 - High);
- Buenos Aires, Argentina (77 - Medium);
- Montevideo, Uruguay (92 - Medium);
- San Jose, Costa. Rica (112 - Medium);
- Panama City, Panama (114 – Medium); and
- Bogotá, Colombia (117 - Medium).

Despite São Paulo's relatively low IESE ranking (132 of 174 cities ranked), due primarily to the disparities in smart city implementation levels across its population, it is, nonetheless, one of the most digitally sophisticated cities in the region and the world. Latin America and Caribbean cities considered in the IESE rankings are highlighted below (*Figure 56).*

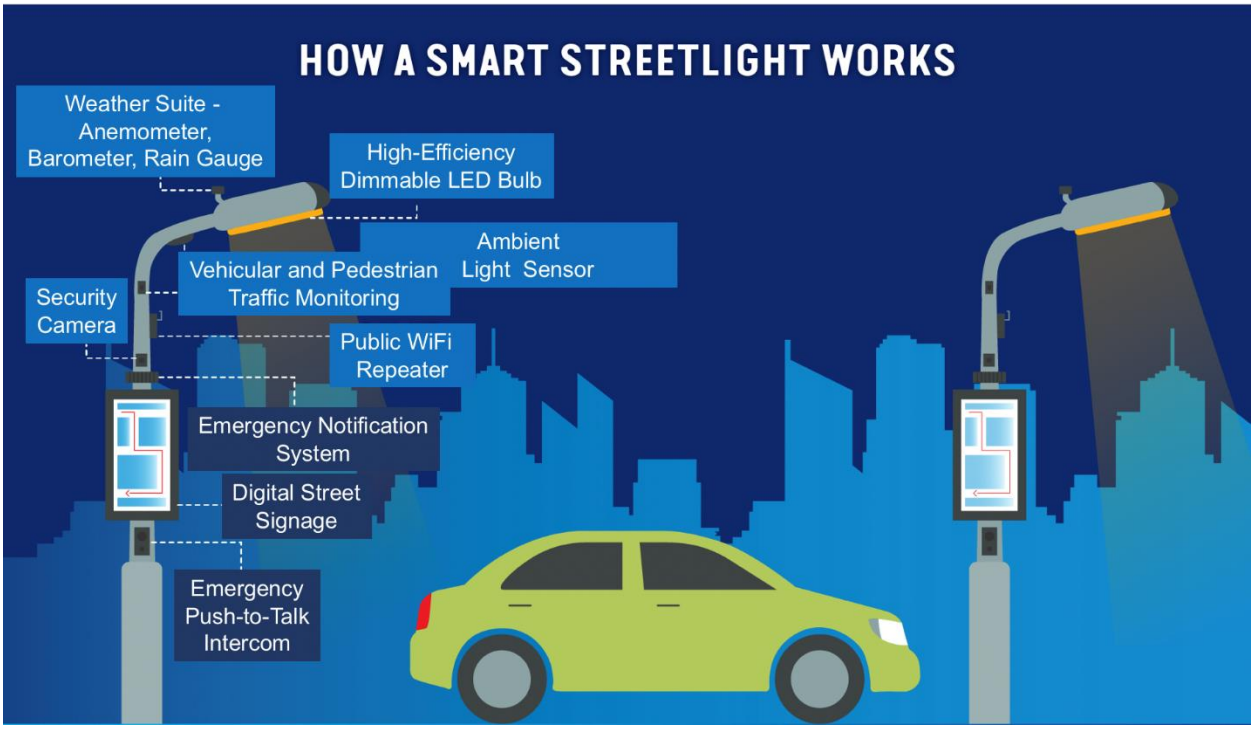
Figure 56: Latin American and Caribbean Cities Considered In IESE Cities in Motion (Smart Cities) Index[87]

[87] IESE

A5.1.2 Smart Street Lighting

One of the early programs typically undertaken on the path toward creating a smart city is smart street lighting. Smart streetlights are networked, intelligent lighting systems consisting of smart lamp posts, LED luminaires, sensors, communication modules, and other peripheral devices. Smart streetlights improve safety, manage municipal energy consumption, and frequently provide both citizen and municipal access to warning and communication features highlighting crimes in progress, as well as impending weather events and natural disasters. Smart street lighting poles may provide public Wi-Fi access and device charging (*Figure 57*).

Figure 57: Smart Street Lighting Features[88]



A5.1.3 e-Government

e-Government applies information and communications technologies, like high speed/high volume communications networks, the internet, and various apps, to enhance government activities, streamline processes, and generate citizen use and interest. These changes serve to increase government efficiency, transparency, and citizen involvement.

At the national/federal level, the Division of Public Administration and Development Management (DPAPM) of the United Nations Department of Economic and Social Affairs (UN-DESA) conducts a bi-annual e-government survey, including an *e-Government Development Index (EGDI)*. It is a comparative ranking of 193 countries of the world using three indicators:

[88] Coolfire Solutions

1. An Online Service Index (OSI) measuring the online presence of the government in terms of service delivery;
2. A Telecommunication Infrastructure Index (TII); and
3. A Human Capital Index (HCI).

The Survey assesses the UN's 193 member states according to a quantitative composite index of e-government readiness based on website assessment, telecommunications infrastructure, and human resources capabilities. The TII, which focuses on ICT availability, considers internet access, fixed and mobile telephone subscriptions, and fixed and wireless broadband availability.

As is the case for smart cities, the top scorers in the EGDI are typically high income-level countries, including West European nations, the United States, and Singapore, as well as South Korea, Australia, and New Zealand.

Uruguay is the only Latin American country with a "very high" EGDI score (34th globally), though Chile, Argentina, and Brazil each fall just shy of this level (*Table 25*). Paraguay falls in the Upper Middle tier of all nations globally. Latin America and the Caribbean, as a whole, showed the largest regional improvement globally between the UN's 2016 and 2018 surveys. Across the Americas, the United States stands at 11th in the world, with Canada ranking as 23rd.

Table 25: The United Nations EGDI Top Ten Americas Countries in e-Government[89]

2018 Americas Rank	Country	EGDI	EGDI Level	2018 Global Rank
1	United States of America	0.8769	Very High	11
2	Canada	0.8258	Very High	23
3	Uruguay	0.7858	Very High	34
4	Chile	0.7350	High	42
5	Argentina	0.7335	High	43
6	Brazil	0.7327	High	44
7	Barbados	0.7229	High	46
8	Costa Rica	0.7004	High	56
9	Colombia	0.6871	High	61
10	Mexico	0.6818	High	64

A5.2 Smart Cities and e-Government - Investment Outlook

The global Smart Cities business opportunity is estimated at $2 trillion by 2025[90], with the Latin American/Caribbean region representing roughly 10 percent of the total. Growth will arise from a global base of about $1 trillion today, although estimates vary widely. The anticipated compound annual growth (CAGR) is 15 percent. Development of Latin American/Caribbean smart cities

[89] United Nations
[90] Frost & Sullivan

currently lags other regions such as Asia, North America, and Europe, but numerous programs are either in process or planned. Estimates suggest that globally, circa 70 percent ownership of smart-cities applications by the public sector, with 60 percent of required initial investment arising from the private sector.[91] In addition to the bricks and mortar and associated services required for developing new buildings and housing developments, a wide range of ICTs will be critical to smart city development and e-Government, including:

- 5G and other telecommunications infrastructure and services;
- Voice assistants;
- Artificial Intelligence (AI);
- Internet of Things (IoT);
- Building automation;
- Sensors;
- Big data;
- Cloud computing;
- Cleantech;
- Distributed energy generation;
- Cybersecurity;
- Surveillance;
- Electric and autonomous vehicles (EV and AV) sensors; and
- Advanced driver assistance systems (ADAS).

The global ICT investment in e-government was approximately $600 to 700 billion in 2019.[92] Communication and IT services represent about two-thirds of investments, while software, devices, and data centers comprise the remaining third. Big Data, the Internet of Things (IoT), and customized apps continue to be new technology focal points for investment.

A5.3 Argentina

Buenos Aires began focusing on using modern approaches to address issues in Public Administration as early as 2008. At the time, paper records resulted in citizen issues and complaints (of which 30,000 per month were typical) going unanswered for as long as eighteen months. Using a digital approach, the city is now able to establish priorities in nearly real-time, as well as address issues within a maximum of 96 hours.

Another issue early on in the Buenos Aires Smart City journey was city safety. To address this, as well as better manage energy consumption, Buenos Aires initiated a smart street lighting effort. By converting its 91,000 streetlights to a digital LED system, the municipality now gets real-time information concerning power outages, broken lights, and vandalism. Also, the city can track contractor information and performance, installation speeds, and maintenance costs.

Other Smart City and e-Government initiatives in the Argentine capital city have included:

[91] McKinsey and Company
[92] Grandview Research

- Smart pipe system to manage drainage and flooding, as well as enhance associated service planning and repair truck deployment. This system is also capable of providing citizen weather alerts predicting flooding.
- Security – including various sensors and digital reporting systems.
- Transportation - including a smart card electronic ticketing system for public transit.
- Education – including the provision of student laptops.
- Healthcare – including telehealth access.

Beyond Buenos, Aires, eight Argentine cities are members of the Open and Agile Smart Cities (OASC) network, a global network connecting 150 smart cities in 30 countries:

- Ameghino;
- Berisso;
- Carlos Casares;
- Coronel Suarez;
- La Plata;
- Lobos;
- Ramallo; and
- Púan.

La Plata serves as the country OASC coordinator. This municipality has undertaken recent smart cities projects, including:

- Parking availability and online parking ticket payment;
- An open data portal; and
- With the National University of La Plata, an Internet of Things (IoT) initiative focused on streetlight sensors to monitor air quality and pollution, including vehicle emissions and noise.

A sensor project to measure river water levels and prevent flooding is also in development.

As another example, Berisso has focused on urban mobility and transportation, urban security, and disaster prevention. In conjunction with the Inter-American Development Bank, the Ministry of Strategy and Finance of the Republic of South Korea, and the Korean Bank Knowledge Exchange Program, Berisso is also working on city finance and governance innovations.

E-Government initiatives throughout the country have succeeded in bridging public service gaps between rich and poor. During the 2020 COVID-19 global pandemic, for example, telemedicine solutions have allowed information, public health safety, and treatment exchanges that previously had not been possible.

Even where digital infrastructure is minimal, regional governments have provided citizen access to creative e-Government solutions. On such example is Autopista de la Información in the Province of San Luis. This digital solution encompasses a web-based network that rings the province with optical fiber, radio and satellite links, a local data center, and specialized apps. In

outlying provincial districts, where there are no telephone lines, mobile satellite uplink vans provide internet access for citizens.

A5.4 Brazil

In 2018, São Paulo, Curitiba, Rio de Janeiro, Belo Horizonte, and Vitoria ranked as the top five Brazilian smart cities based on 11 development indicators.[93]

São Paulo has focused on using digital tools and technology to reduce city bureaucracy. Its Descomplica (Uncomplicate) program, which includes Descomplica Digital, a specialized training, and electronic application and services portal, offers more than 350 digitized municipal services. The city also hosts a large and vibrant innovation/entrepreneurship cluster, attracting a high proportion of Brazilian invested capital, as well as tech giants, including Amazon, Google, Netflix, and Spotify. A challenge to full smart cities implementation in São Paulo is the concentration of wealth in certain areas and not in others, making uniform service delivery challenging. As a result, lists of top smart cities frequently omit São Paulo, despite its overall regionally and globally strong digital infrastructure.

In 2017, Curitiba began a smart city initiative, "Vale do Pinhão," to accelerate smart city development projects. Vale do Pinhão includes several pillars to better integrate the municipal government with key stakeholders, including universities, not-for-profit organizations, companies, and citizens. Upcoming projects span smart street lighting, transportation capacity management, and a city innovation hub. Also, Curitiba plans to develop a "Digital Wall" to increase municipal security using a fiber-optic network and a new monitoring center.

Building upon efforts initiated for the 2014 FIFA World Cup and the 2016 Olympics, Rio de Janeiro has been proactive in developing smart-city projects, as well. Early projects focused on safety and security, spanning citizen and visitor safety, early warnings for weather-related disaster prevention, and freedom of information. More recent projects have included enhanced mobility, modernization of traffic infrastructure (Digital Traffic), and air quality enhancement. By 2019, Rio de Janeiro ranked as 48th of the 50 top Smart City Governments[94] globally, the only Latin America Caribbean region city included. Selection criteria included:

- Vision;
- Leadership;
- Budget;
- Financial incentives;
- Support Programs;
- Talent-readiness;
- People-centricity;
- Innovation ecosystems;
- Smart policies; and
- Track record.

[93] Connected Smart Cities.com.br
[94] Eden Strategy Institute and ONG&ONG

Belo Horizonte programs to date have focused on enhancing mass transportation and addressing the loss of life from natural disasters such as flooding and landslides. The city also hosts several hundred startups as a result of its innovation efforts. Vitoria's focus has spanned health, education, e-governance, and promoting innovation and entrepreneurship among its population.

Thirteen Brazilian cities are members of the OASC network:

- Anapólis (Goiás);
- Colinas do Tocantins (Tocantins);
- Cuiabá (Mato Grosso);
- Garanhuns (Pernambuco);
- Nova Friburgo (Rio de Janeiro);
- Olinda (Recife) (Pernambuco);
- Parnamirim (Rio Grande do Norte);
- Porto Alegre (Rio Grande do Sul);
- Recife (Pernambuco);
- Rio das Ostras (Rio de Janeiro);
- Taquaritinga (São Paulo);
- Uberlândia (Minas Gerais); and
- Vitória (Espírito Santo).

A5.5 Paraguay

Paraguay ranks as an upper-middle-tier nation in terms of connectivity and e-government by the UN. Working to address its broadband access and cost position given the country's landlocked status, Paraguay is currently positioning for a stronger future of smart cities.

Paraguay has continually upgraded and sought to expand citizen access to telephony and the internet. Projects identified to continue the country's progress include: a high-capacity fiber optic cable linking the capital city, Asunción, to the international subsea fiber optic cable network via the landing station at Las Toninas, Argentina, and the development of a Digital District in Asunción, intended to become the country's focal point for ICT innovation. The 2020 COVID-19 global pandemic has witnessed Paraguay enhance its e-government capabilities by implementing enhanced telemedicine and citizen/medical care worker information provision.

A6 INTERNET of THINGS (IoT) and ARTIFICIAL INTELLIGENCE (AI)

A6.1 Sector Overview

The Internet of Things (IoT) and Artificial Intelligence (AI) are closely related. IoT is the networking capability allowing information to be sent to and received from objects and devices (such as home appliances, industrial systems, and modes of transportation) using the Internet. AI is the capability of a machine to imitate intelligent human behavior. AI is often incorporated in IoT applications to enhance performance and better predict user needs.

A6.1.1 The Internet of Things (IoT)

The Internet of Things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A *"Thing"* may be: an automobile with sensors monitoring/adjusting performance systems; a person with an electronic implant such as a pacemaker; livestock/individual animals with a biochip transponder; a manufacturing plant or piece of equipment with smart sensors; or any other natural or human-made object which may be assigned an Internet Protocol (IP) address and can transfer data over a network.

IoT ecosystems comprise web-capable smart devices using embedded processors, sensors, cameras, and communication hardware to collect, send, and act on data acquired from their environments. IoT devices share the sensor data collected by connecting to an IoT gateway or other edge device and send it to the cloud for processing (or sometimes local analysis). IoT devices generally operate without human intervention. Humans do interact with the devices; however, for set up, instruction, and access to information resulting from machine data analysis (*Figure 58*). IoT devices frequently communicate with other related devices, as well as act on the information obtained from one another. IoT devices can also use artificial intelligence (AI) and machine learning to make data collection and analysis processes easier and more dynamic.

IoT benefits include:

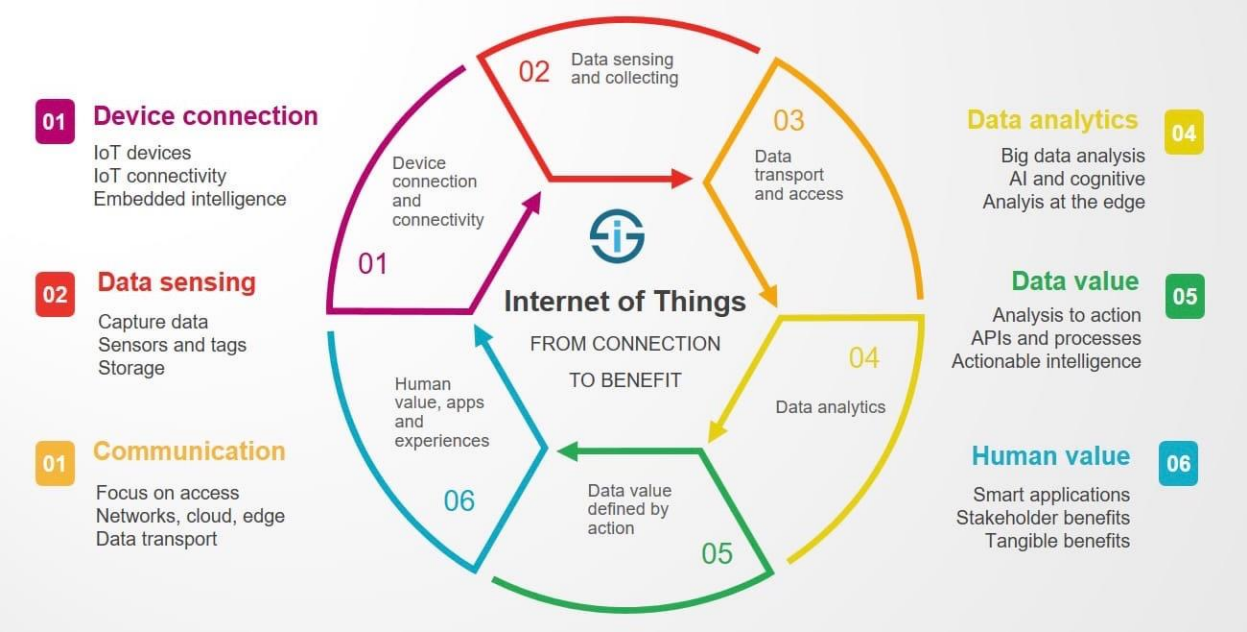
- Access to information from anywhere at any time on any device;
- Improved communication among connected devices; and
- Task automation, improving business, consumer, and production process efficiency, while also reducing human intervention and required labor.

Challenges to wide IoT adoption include:

- The need for a uniform international standard of compatibility for IoT, lack of which currently limits the abilities of devices from different manufacturers and regions to communicate with each other;
- The ability of enterprises to manage with massive numbers of interconnected IoT devices (up to and. including in the millions) and the associated challenges in collecting and managing extensive quantities of data;

- The possibility all interconnected devices will become corrupted if a bug manifests in one; and
- The potential that hackers may steal confidential information, particularly as the number of connected devices increases and more information is shared among devices.

Figure 58: Internet of Things (IoT) Data and Benefit Cycle [95]



IoT uses span numerous markets and applications including but not limited to:

- Home (security, appliances, automation);
- Industrial and utilities (process control, machine-to-machine automation, logistics);
- Transportation (aircraft, railroad and light rail, vehicular);
- Agriculture (soil and crop management, livestock care);
- Government and military (smart cities, aerospace and defense, and e-government);
- Healthcare (telemedicine, predictive diagnostics, robotic and image-guided surgery);
- Environmental (weather and climate management and prediction, fire and flood detection, wildlife management);
- Retail (logistics, inventory control, security); and
- Building and construction (fault prediction, energy management, and heavy machinery control).

Today, in the Latin American/Caribbean region, Brazil hosts just under half of regional IoT devices, with Mexico and Colombia representing the next two largest users. The rest of Latin America, in total, comprises 20 to 25 percent of current IoT device usage.

[95] I-Scoop.eu

A6.1.2 Artificial Intelligence

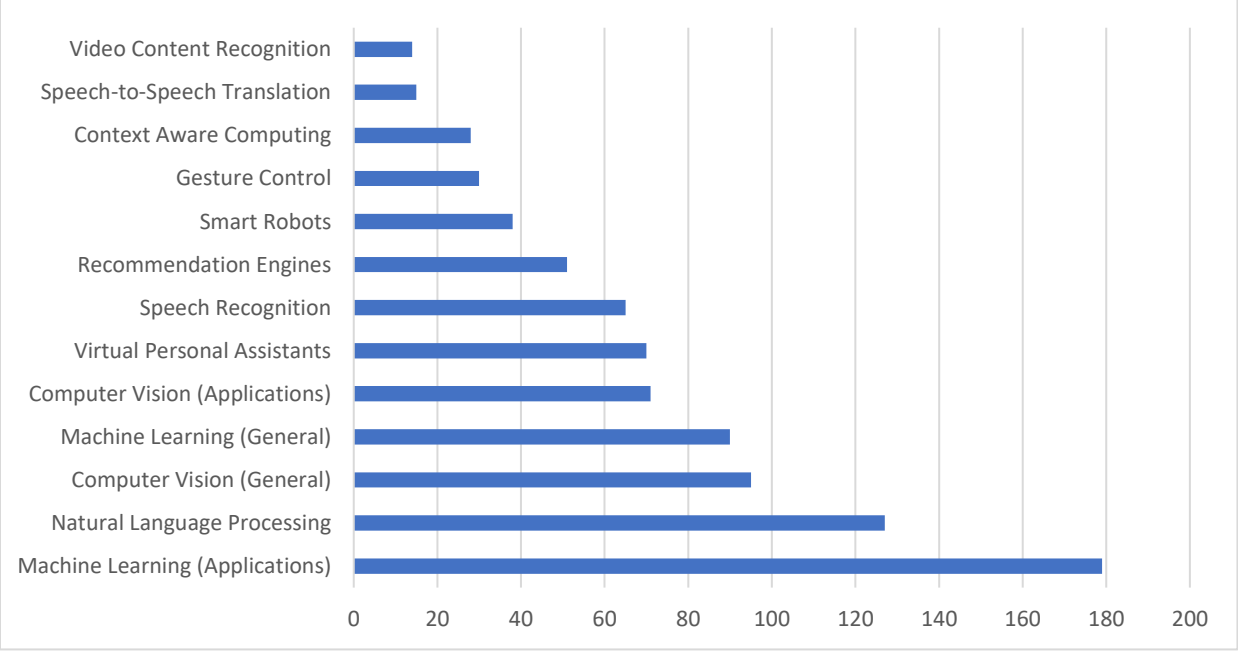
Artificial Intelligence (AI) is the simulation of human cognitive capabilities in machines programmed to think and mimic the actions of people. Any machine exhibiting traits associated with a human mind, such as learning and problem-solving, may be described as using artificial intelligence. The key characteristic of AI is its ability to rationalize and take actions having an optimized chance of achieving a specific goal.

Artificial intelligence divides into two categories:

- **Weak:** a system designed to carry out one particular job (e.g., playing chess or personal assistants such as Amazon's Alexa or Apple's Siri where the assistant is asked a question and answers it); and
- **Strong:** typically complex systems performing multiple tasks considered human-like, programmed to handle situations requiring problem solutions without human intervention. (e.g., self-driving cars or robotic and image-guided surgery).

AI technologies are evolving rapidly. Over 800 companies are developing AI technologies and solutions spanning: machine learning; computer visioning; language processing, recognition and translation; and movement and context recognition and interpretation (*Figure 59*).

Figure 59: Artificial Intelligence Innovation Areas, 2020 (Number of Companies Developing Solutions)[96]



[96] Venture Scanner

AI solutions offer benefits including:

- Labor and home/personal management cost reduction;
- Worker safety (e.g., allowing machines to replace humans in risky environments);
- Ability to perform tasks more quickly and effectively than the average human (e.g., reading digital medical images and performing complex surgeries); and
- Scalability and 24/7/365 service availability and access from any location.

Since the start, however, AI has come under scrutiny from scientists and the public. A key issue is the replacement of human labor by machines, potentially leading to mass unemployment. Another concern is that machines may become so highly developed that humans will not be able to keep up with machine learning, creating a prospect that machines could evolve themselves to take over society. Yet another is that AI devices may have the ability to hack into human privacy or be weaponized. Many debate the ethics of artificial intelligence and how intelligent systems should be treated legally vis-à-vis human rights.

For Latin America, which has historically lagged more developed regions in worker productivity, AI offers an opportunity for the region's economies to leapfrog to greater innovation and economic progress. Research suggests AI can add a full percentage point of GDP to five of South America's largest economies (Argentina, Brazil, Chile, Colombia, and Peru) by 2035.[97] By year-end 2019, 79 percent of Latin American companies had launched AI initiatives, with fewer than two percent reporting lower than expected investment returns.[98]

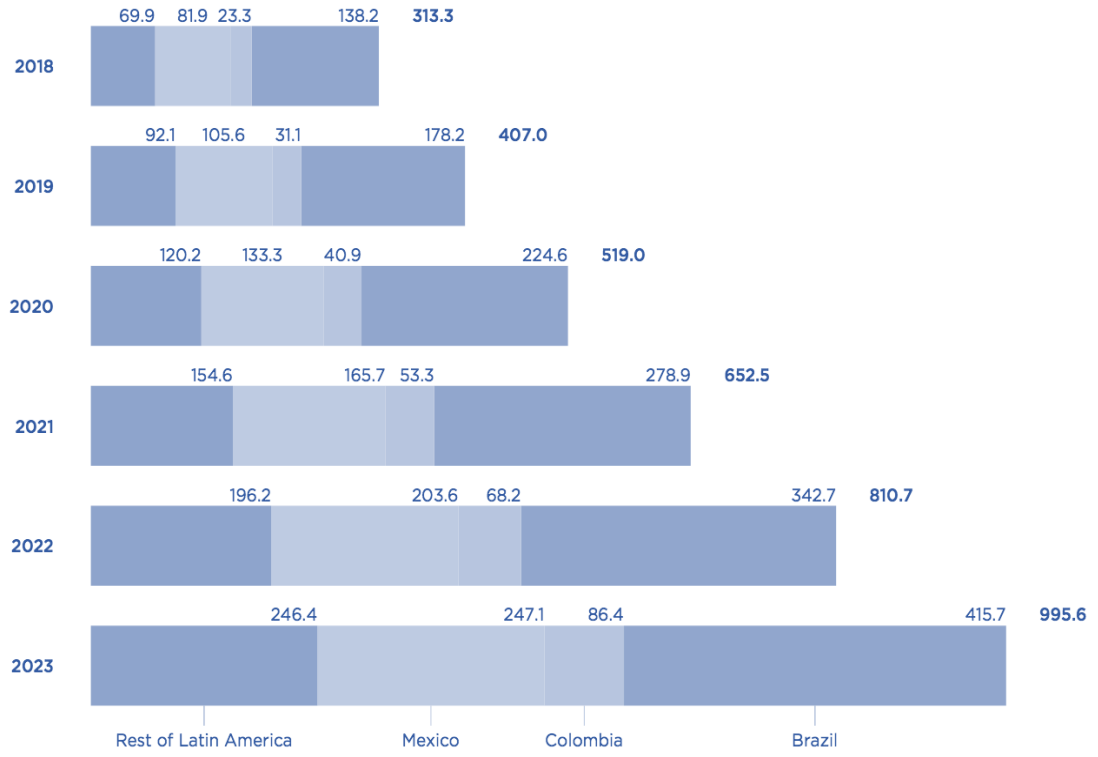
A6.2 Internet of Things (IoT) and Artificial Intelligence (AI) Investment Outlook

In 2019, the global market for IoT was approximately $745 billion.[99] By 2025, projections suggest 41.6 billion IoT devices will be connected globally, generating 79.4 zettabytes of data. Global spending will exceed $1 trillion by 2022.[100]

In 2017, the Latin American/Caribbean region hosted 400 million connected devices. By 2023, MIT forecasts that number will reach over one billion connected IoT devices. The region will represent the fastest growth in IoT spending through 2025. While Brazil is and will remain the largest IoT device consumer, Mexico (28.3 percent compound annual growth rate (CAGR)), Colombia (24.9 percent CAGR), and Chile (23.3 percent CAGR) are projected to lead growth in the region (*Figure 60*).

[97] Inter-American Development Bank
[98] Massachusetts Institute of Technology (MIT)
[99] Ibid
[100] Ibid

Figure 60: Latin America and Caribbean Internet of Things (IoT) Device Forecast, 2018-2023 (million units)[101]



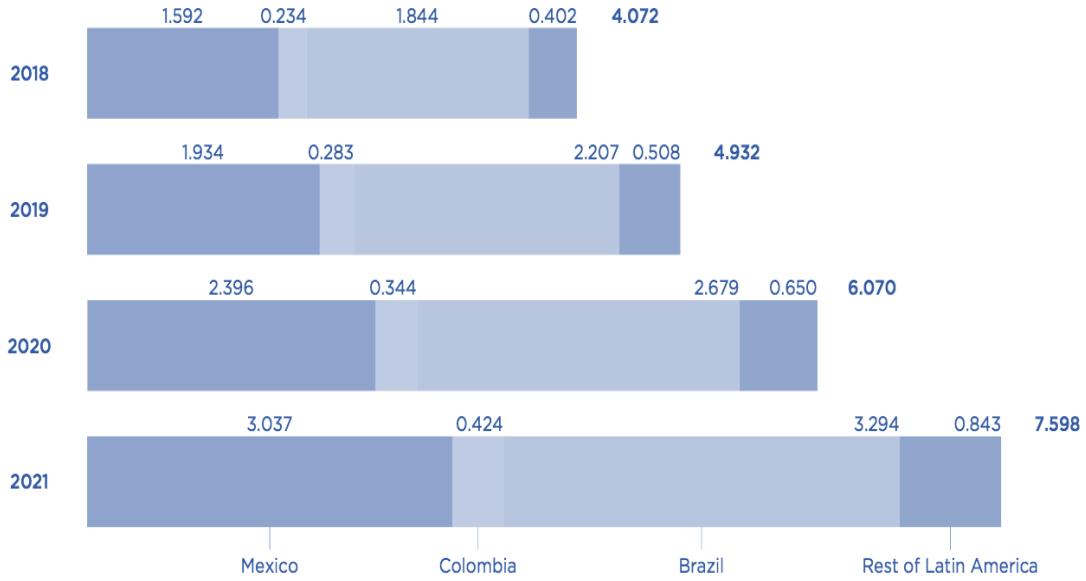
The foregoing device numbers translate to a regional market of almost $5 billion in 2019. The Latin American/Caribbean region IoT market will grow to $7.6 billion by 2022, or at a compound annual growth rate of above 20 percent (*Figure 61*).

Globally, the AI market is estimated to reach nearly $750 million by 2027, growing at double-digit rates.[102] Today, the United States represents over 40 percent of the market. Growth will be driven by several factors, with big data providing traction and image processing being a critical application area. The large amount of data required to train AI systems for character and image recognition has, to date, constrained growth.

Although the Latin American/Caribbean region AI market is small today (various estimates suggest under $1 billion in 2019), the geography is already seeing substantial economic benefits from artificial intelligence. Visa, for example, reported that artificial intelligence allowed regional financial institutions to avoid $2 billion in credit card fraud in 2019 on a payment volume of $430 billion.

[101] Ibid
[102] Reportlinker

Figure 61: Latin American and Caribbean Internet of Things (IoT) Revenue Forecast, 2018-2023 ($ billion)[103]



A6.3 Argentina

Argentina has begun IoT and AI implementations in both the public and private sectors. In the public sector, smart cities initiatives using one or both technologies include Buenos Aires proper, Tigre City and San Nicolas de los Arroyos (both in the greater Buenos Aires area), as well as several others. Buenos Aires has undertaken a public-private partnership (PPP) with Phillips Lighting to develop a smart street lighting system using data from multiple municipal departments to optimize streetlight usage and reduce associated power consumption by half. Tigre City has focused on improving citizen safety using IoT cameras to aid local law enforcement in tracking stolen vehicles, reducing vehicle thefts by 80 percent. San Nicolas do los Arroyos has worked with Telefónica to use IoT to manage the municipal vehicle fleet, more efficiently. In real-time, the municipality knows where its connected vehicles are, enabling movement coordination and resulting savings on fuel and maintenance costs.

In early 2020, Nokia signed a contract with Argentine telecom operator Telecom Argentina to allow the operator to offer IoT services to its domestic enterprise customers and across Latin America using Nokia's Worldwide IoT Network Grid (WING). The WING technology will provide Telecom Argentina's customers with opportunities to implement IoT and associated AI solutions in various industry verticals, including automotive, agriculture, utilities, finance, and services.

Oil and gas producer, YPF, has been at the forefront in Argentina for both industrial IoT and AI use. The company has adopted a Digital Agenda reviewed later in this section.

[103] Inter-American Development Bank

A6.4 Brazil

In October 2017, Brazil adopted a National IoT Plan. This plan was predicated on the success of the 2010 Brazil National Broadband plan that was instrumental in the rapid adoption of broadband technologies and capabilities in the country. That plan managed to bring 1Mbps broadband access to all municipalities in Brazil at low prices and led the way for many other telecommunications services and technologies to reach the population.

The IoT plan provides a basis for developing all IoT sectors, with a few priority areas chosen for acceleration based on country technical capabilities and likely demand. Many include the use of AI. Areas for acceleration include:

- ***Smart Cities***: mobility, public safety, and utilities including smart metering;
- ***Health***: IoT application to chronic disease management, prevention of epidemics, and improved efficiency and cost reduction in hospitals;
- ***Rural***: efficient usage of natural resources, inputs and machinery, and sanitary safety;
- ***Heavy Industry and Manufacturing***: process improvement, new equipment, product development, and new business model generation incorporating AI, IoT, and solutions integrating supply chains of goods, components, services, and inputs; and
- ***Agriculture***: productivity improvements (with targets of up to 25 percent enhancement), reduction of inputs, especially pesticides and chemical fertilizers (with targets of reductions as high as 20 percent), and livestock management (e.g., eliminating human labor from monitoring animal weight).

A6.5 Paraguay

Internet of Things and Artificial Intelligence adoption is beginning to develop in Paraguay. A key challenge currently to IoT and AI adoption in the country is access to high-speed, high-capacity communications networks with which to process the vast amounts of data required for these newer technologies. The Paraguay International Connectivity project reviewed in the Paraguay chapter of this Resource Guide will begin to create an opportunity for faster adoption.

A7 DIGITAL HEALTHCARE and TELEMEDICINE

A7.1 Sector Overview

Digital Healthcare comprises segments reliant on ICT technology for improved medical diagnosis, treatment and patient outcomes, patient tracking and recordkeeping, and simplification/labor reduction of hospital and medical office administration and business processes (*Table 26*). The sector spans hardware, software, and associated services.

Table 26: Digital Healthcare Market Segmentation

Segment	Sub-segments
Diagnosis and Treatment	Telehealth/telemedicine
	Mobile health (m-Health)/mobile medicine
	Wireless health/wireless medicine
	Home/wearable diagnostics (glucose, neurological, sleep apnea, blood pressure, pulse oximetry, *et al*)
	e-Prescribing systems
	Medical and fitness apps
	ICT-enabled medical devices
	Medical imaging
	Medical robotics
Patient Tracking and Record Keeping	In-hospital patient monitoring (critical care, neonatal, surgical suite)
	EHR/ePHR (electronic health record/ electronic portable health record for patient use)
	EMR (electronic medical record – for healthcare provider use)
	e-Prescribing systems
	Mobile health (m-Health) apps
	Healthcare analytics
Hospital and Medical Office Administration	Healthcare information systems
	Cloud storage
	On-premises storage
	Medical cybersecurity

Users of Digital Healthcare include:

- Patients,
- Healthcare providers (e.g., physicians, nurses, medical technologists, emergency medical technicians, *et al*),
- Hospital and medical office administrators,
- Payers/insurers, and
- Pharmaceutical, medical device, and medical capital equipment suppliers.

A key component of Digital Healthcare delivery in the Latin America and Caribbean region, particularly in Brazil, Argentina, and Paraguay, is telemedicine. Telemedicine is the use of telecommunication and information technologies to provide clinical health care at a distance (*Figure 62*). Telemedicine eliminates distance barriers and improves access to medical services otherwise not readily available in distant rural or less affluent communities. Also, telemedicine saves lives in critical care and emergency cases.

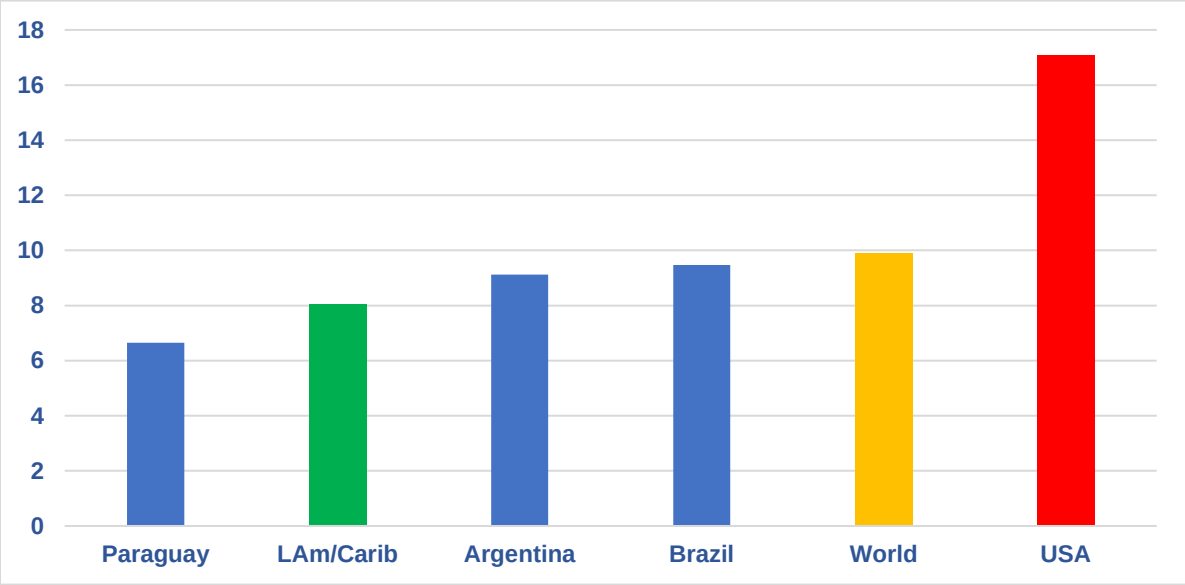
Figure 62: Telemedicine in Action[104]

A7.1.1 Regional Healthcare Demographics and Patient Populations

Healthcare expenditures vary widely, both globally and regionally. The world average of healthcare expenditures as a share of GDP is approximately 10 percent. The countries considered in this Resource Guide range from a low of 6.7 percent to a high of 9.5 percent. As a comparison, the United States, spends the greatest share of GDP on healthcare, at just over 17 percent (*Figure 63*).

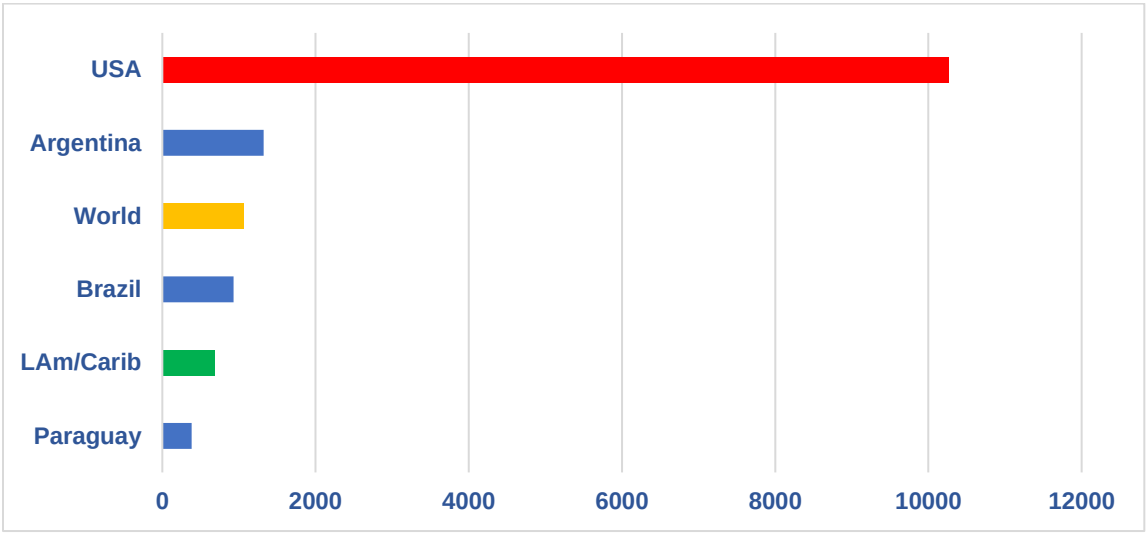
[104] Vyopta

Figure 63: Healthcare Expenditures as a Percent of GDP, 2016[105]



On a per-capita basis, all three countries spend far less per capita on healthcare than the United States (*Figure 64)*. Nonetheless, each of the three countries has been assertive in developing digital healthcare and telemedicine and represents investment opportunity in markets exceeding $1 billion.

Figure 64: Relative Healthcare Expenditure per Capita ($), 2016-2018[106]



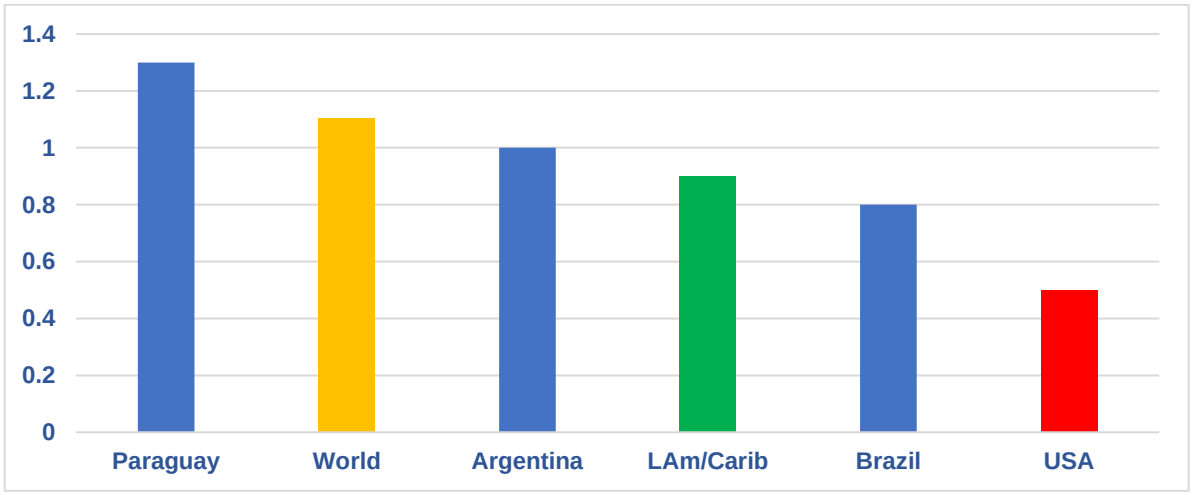
[105] World Bank – most recent year reported
[106] Ibid

Factors influencing growth in healthcare expenditures include[107]:

- Population growth/number of births,
- Aging of population/prevalence of end-of-life care,
- Disease prevalence/incidence, and
- Frequency of service utilization/service price and intensity.

Argentina, Brazil and Paraguay all have substantially higher birth rates than the United States (*Figure 65*). At the other end of the spectrum, Paraguay and Brazil have a somewhat lower percentage of elderly (age 65 and above) than the global average (*Figure 66*), while Argentina is above world levels. All have younger populations than the United States. In terms of life expectancy (*Figure 67*), all three countries are above the world average and slightly below the United States.

Figure 65: Population Growth[108]



[107] *The Journal of the American Medical Association (JAMA)*
[108] World Bank

Figure 66: Aging Population (percentage), 2018[109]

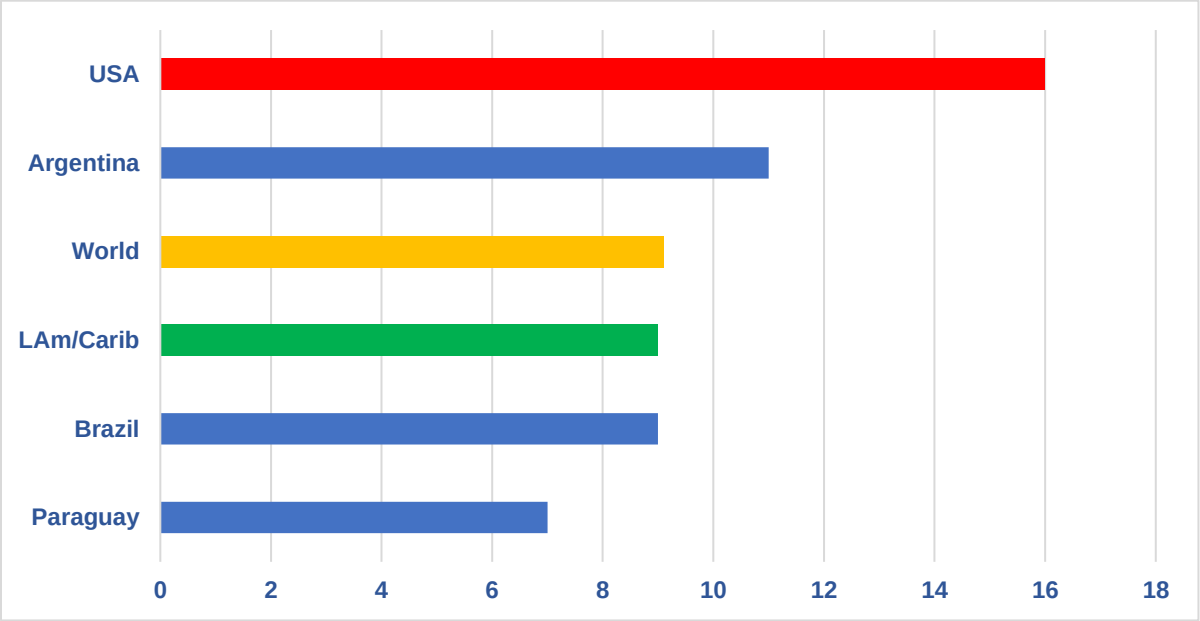
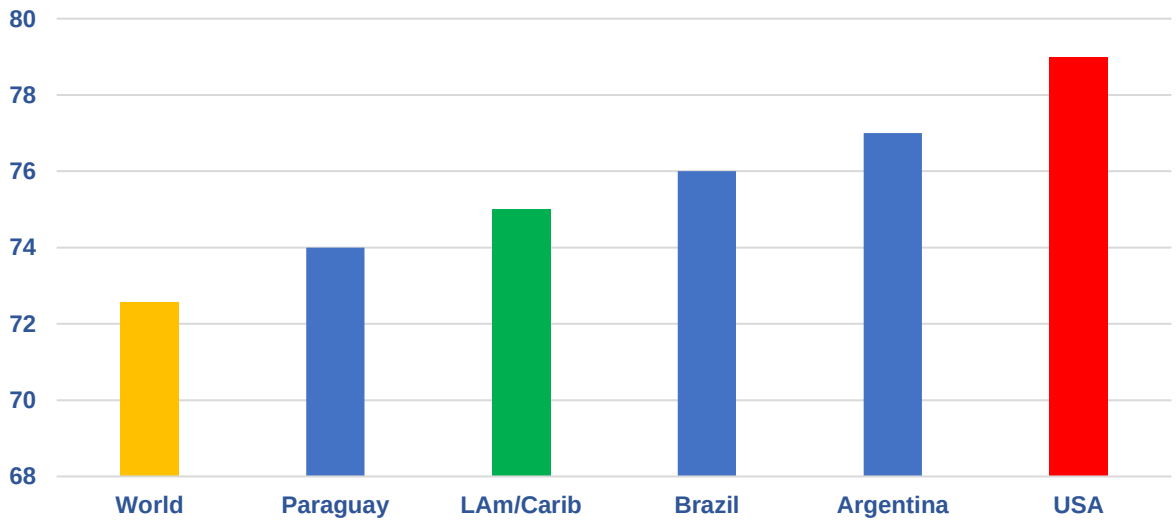


Figure 67: Life Expectancy (Years), 2019[110]



Demographic data, the existence of remote patient populations, and the drive toward ever-more competitive economies by Brazil, Argentina and Paraguay, suggest the likelihood of substantial growth in investment in the Digital Health sector. Increasing demand for Digital Health products and services align regional needs with U.S. technological, manufacturing, and service capabilities.

[109] Ibid
[110] World Population Review

A7.2 Digital Health Investment Outlook

The 2020 global COVID-19 pandemic has strengthened impetus for Digital Healthcare in the Latin American/Caribbean region and particularly across the three countries covered in this Resource Guide, given their sizeable populations. Telemedicine, particularly, is being increasingly recognized as a solution to achieve more with less. Across these three countries, Digital Healthcare has a strong potential to address the disparity of healthcare resources between urban and rural populations.

The global digital healthcare market in 2019 was just over $100 billion,[111] of which telemedicine represented $45 billion,[112] though estimates vary widely. Various projections suggest the market will exceed $500 billion by 2025, with telemedicine reaching at least $175 billion in the same period. Other large segments are health-related apps, Digital Health hardware/devices, and health analytics services. Most sources project compound annual growth rates between 20 and 30 percent over the next five years.

The Latin American/Caribbean region constitutes in the range of five percent[113] of the global market with somewhat slower, but still double-digit, growth. Argentina, Brazil, and Paraguay combine to represent over 50 percent of the Latin American/Caribbean regional market today, and represent over a billion-dollar Digital Healthcare market. The three countries included in this Resource Guide are home to 40% of the region's patient population.

The future of Digital Healthcare across Brazil, Argentina, and Paraguay is promising. The three governments are all investing in and taking active roles in digitizing their health systems and building the necessary infrastructure to support these initiatives. The World Health Organization (WHO) and The Pan American Health Organization (PAHO) have been proactive in supporting the alleviation of country healthcare disparities. Also, numerous private companies are working to develop or expand their presence. The 2020 pandemic has enhanced cross-border sharing of Digital Healthcare knowledge, resources, and support.

A7.3 Argentina

Argentina is the second largest healthcare market in the Latin American/Caribbean region. Approximately 50% of residents use public healthcare, which includes both inpatient and outpatient services. Another 45% utilize Obras Sociales, employer/trade union-based insurance plans (or "mutuals"), where the employer/union and the employee each pay a fixed fee. The remaining five percent of patients seek medical care in the private sector. Argentina also hosts a medical tourism industry with particular emphasis on cosmetic surgery.

Healthcare in Argentina is easily accessible in large cities, especially Buenos Aires, but inequality exists, particularly in more remote and less affluent areas. The country hosts in more than 5,000 medical facilities, of which roughly 70 percent are private and 30 percent public.

[111] Grandview Research, Global Market Insights, *et al*
[112] Statista
[113] Grandview Research, Global Market Insights, *et al*

The Ministry of Health and Social Action (MSAS) monitors the three Argentine healthcare sectors: public, social security, and private. The office of the Government Secretary for Health is currently overseeing the development of a National Telehealth Plan, 2018-2024. This plan highlights three strategic axes: 1) strengthening the institutional governance of a new modality of remote health work; 2) managing the Argentine Telehealth network; and 3) developing telecare and telemedicine programs. Formation of a Telehealth Advisory Group, charged with evaluating, reviewing, and discussing key themes of the telehealth agenda at the national, regional, and international levels, is also part of the plan.

The Ministries of Health (MoH) and Federal Planning, Public Investment & Services have been charged with promoting Digital Healthcare, particularly Telemedicine, via the CyberHealth Project. The project focuses on the installation of fiber optic transmission cables, as well as upgrading hospitals to allow for videoconferencing. The CyberHealth project plan includes connecting 325 healthcare institutions across Argentina to facilitate remote consultations and expertise sharing.

Nongovernmental agencies have also supported Digital Health development in Argentina. For example, the WHO, in partnership with the PAHO, supported the implementation of an educational telehealth project in the province of Jujuy. The World Telehealth Initiative currently has two women's and children's programs in Northern Argentina: one at Hospital Público Materno Infantil de Salta, a women and children's hospital; the other at Centro Provincial Eva Peron, a pediatric hospital in Santiago del Estero. Both initiatives link to the capabilities of the Garrahan Hospital of Pediatrics in Buenos Aires. Previously, care required flights of two hours or more.

Private companies are participating in Digital Healthcare development in Argentina. Two pilots have focused on reducing cardiac diagnosis and treatment times. U.S.-based GlobalMed is working with Argentine Meditar, one of the largest managed care providers in Latin America, to develop TeleMeditar, a telemedicine system for health care delivery across Argentina and to neighboring nations. TeleMeditar will serve one million patients in its initial stage. Meditar's areas of medical specialization include:

- Neurosurgery
- Cancer surgery
- Orthopedics
- Traumatology
- Cardiovascular surgery
- Ophthalmological surgery
- Organ transplants
- Assisted reproduction
- Cosmetic surgery
- Cosmetic dentistry

Several Argentine venture businesses also are pursuing Digital Health, with offers spanning:

- Audiology apps
- Medical consultation facilitation

- Tele-education
- Imaging analysis
- Social network/medical provider comparison app
- Medical administration via the cloud
- Medical institution management software

Recently, Argentina, with the support of the Federation of Collegiate Medical Entities (CONFEMECO), introduced a project to regulate the use of virtual Digital Health applications to ensure the safety and efficacy of medical treatment in public health institutions, as well as to reduce the possibility of records counterfeiting. The project requires any digital application that serves to provide consultations, treatments, or any type of medical care to register with the National Secretariat of Health.

Argentina is well-positioned to grow in Digital Healthcare. Despite currency devaluations and inflation, the country has a history of successfully working with international and U.S. partners, with the United States being the largest foreign investor in the country.

A7.4 Brazil

Brazil is the largest healthcare market in the Latin American/Caribbean region. Healthcare is a Constitutional right in Brazil. Approximately 80% of the population utilizes the public Unified Health System (SUS), while (primarily) the more affluent 20% tend to use private healthcare, sometimes outside the country. Brazil also has a thriving medical tourism industry. The country is home to more than 6,500 hospitals, more than 70% of which are private.[114] Historically, Brazil has emphasized the training of family doctors over specialists, resulting in shortages in certain medical disciplines.

Digital health technology investment focal points in Brazil include:

- Artificial intelligence (AI);
- Automation;
- Big data;
- Mobile applications/wearables; and
- Telemedicine.

To date, Digital Healthcare in Brazil has focused heavily on provider-to-provider interactions, given Government concerns regarding patient privacy. Multiple regulators influence Digital healthcare in Brazil, including the Ministry of Health (MoH), the National Supplementary Health Agency, the National Health Surveillance Agency, and the Federal Council of Medicine. Current issues for digital healthcare in Brazil are:

- Security and privacy of information shared by patients;
- Computer integration of the Brazilian public health system;
- Development of a specific Digital Health regulatory framework;

[114] KPMG

- Integration of the variety of regulators overseeing the sector;
- Changing behaviors and routines to ensure the medical efficacy of new technologies; and
- The need for additional financial and technological resources.

The use of Telemedicine was driven historically by the need to provide care virtually between healthcare providers in urban centers and patients in remote areas, as most rural areas lacked sufficient medical specialists. Since 2006, Brazil has facilitated two public initiatives: the Brazilian National Telehealth Network Program (Telessaúde Brasil Redes (TBR) under the auspices of the MoH); and the RUTE-Telemedicine University Network (under the Ministry of Science, Technology, and Innovation), both of which deploy telemedicine across Brazil.

One of Brazil's first Digital Health initiatives began in 2006 in Parintins, a city of 100,000 located in the middle of the Amazon. With no roads to or from the city, the goal was to use Telemedicine to enable communication between physicians in Parintins and specialists in São Paulo. Parintins partnered with private technology companies, including Intel, to build the required infrastructure (e.g., a WiMAX (Worldwide Interoperability for Microwave Access) network). This telemedicine program continues to operate and has informed other telemedicine efforts, including Telessaúde.

Brazil created Telessaúde to meet better the country's health needs while proactively integrating ICT technologies. The majority of the Brazilian population has access (via their healthcare providers) to the platform.

Another major initiative in Brazil is to bring intensive care unit (ICU) services to rural areas. The Brazilian MoH-initiated tele-ICU programs allow more sophisticated hospitals to connect to rural parts of the country. These tele-ICUs reduce the need to transport patients into a city for health conditions such as heart attacks, strokes, and sepsis. Physicians in urban areas collect and interpret vital signs in real-time and use pan-tilt-zoom (PTZ) cameras to inspect visually patients in remote locations. U.S. Digital Health company, Cerner, in partnership with Brazilian companies Intensicare and IMFtec, has provided the technology and software for many of these virtual ICUs.

Opportunities to enhance digital healthcare in Brazil include:

- Provision of computing capability in many rural hospitals and even some city emergency rooms;
- Systematic collection of patient and treatment data;
- Implementation of hospital quality metrics and accreditation;
- Patient portability of medical records given the foregoing; and
- Extension of digital connections to remote regions.

Despite the challenges, Digital Health opportunities in Brazil are many, both in large cities and among underserved populations. The 2020 global pandemic witnessed the launch of several Digital Health capabilities, including dissemination of information on the availability of testing; disease transmission and treatment; a website with chat feature to check symptoms; a public awareness app; and, for healthcare workers/providers, a chat tool with a direct linkage to a SUS ombudsman for fast issues resolution. Several venture-backed companies in Brazil are pursuing a range of technologies from apps to sophisticated AI for healthcare delivery.

The Ministry of Health is planning to develop a health database over the next five years. The database will include patient information from basic healthcare providers across the country, including consultations, hospitalizations, medications, tests, and vaccines.

Brazil continues to grow its Digital Healthcare and Telemedicine capabilities with support from both the public and private sectors. Investment opportunities align well with American medical ICT capabilities.

A7.5 Paraguay

Paraguay provides universal healthcare to residents and foreigners, including coverage for emergency treatment, diagnostics in all specialties, dental, ophthalmological, and outpatient services. Private health insurance is also available. The country is home to 1,000 public hospitals and a much smaller number of private ones, mostly in Asunción. Paraguay continues to invest in its public health system to improve coverage across the country, to enhance service to rural and underserved patient populations. Currently, about five percent of the population utilizes private healthcare.

The Ministry of Public Health and Social Welfare (Ministerio de Salud Pública y Bienestar Social (MSPyB)) sets the standards for medical facilities, medical professionals, and drug approval in Paraguay. It also oversees issues of unemployment, welfare, and social justice. Dirección de Vigilancia Sanitaria, a directorate under MSPyB, regulates medical devices.

To date, the use of Digital Healthcare has been somewhat limited in Paraguay, despite lack of access to specialty care and diagnostic services for people living in rural areas. In 2011, the World Health Organization (WHO)/Pan American Health Organization (PAHO) focused concern on epilepsy patients among remote and socioeconomically vulnerable populations who lacked access to electroencephalogram (EEG) services and treatment.

Shortly thereafter, the MSPyB placed focus on cardiovascular disease, cancer, and maternal mortality as issues of importance for the country, all of which require ICT diagnostic tools such as electrocardiograms (EEGs), ultrasound imaging (US), and computed tomography (CT). Similarly, these services were not readily available to those living in vulnerable conditions.

As a result, a telemedicine system, through an international collaboration of the MSPyB, the University of Asunción, the University of Basque, the Italian Hospital of Buenos Aires, and the WHO/PAHO Paraguay country office, was tested, offering the three diagnostic modalities (EEG, US, and CT), beginning in late 2015. The telemedicine software system was installed in remote area hospitals, allowing connection to/transmission of images to specialists distantly located in major medical centers. While patient response was highly favorable, healthcare providers were concerned about the availability of trained technicians in the patient locations, remote diagnosis accuracy, and low internet connection speeds, which slowed expansion.

Recently, a private company, MediGet, has introduced an internet-based app usable via cell phone, tablet, or computer to allow remote medical consultations. Doctors pay a small monthly subscription fee to participate and receive most of the consultation fee, while patients receive a

low cost ($15 to 25) consultation. The app includes digital scheduling, payment, and access to telemedicine intended to supplement, not replace, face-to-face care. A second and separate initiative, Dr. Click, reportedly covers a different set of medical specialties. The Committee on Science and Technology of the Chamber of Deputies has reviewed Dr. Click, but has not yet approved.

The 2020 global COVID-19 pandemic has accelerated the pace of Digital Health, particularly telemedicine, proposals in Paraguay. The Ministry of Information and Communications Technologies (MITIC) has created a web portal to provide access to information on the coronavirus, a tracking mechanism to monitor viral spread, and the means for direct communication with the Ministry of Health. Initially, Paraguay's digital transformation project included only the digitization of bureaucratic processes and the support of a digital economy. However, after the outbreak of COVID-19, a congressional Health Emergency Bill created the impetus for the digitization of Estate processes, including health services.

ANNEX B: LIST OF ACRONYMS

List of Acronyms

ACRONYM	DEFINITION
3D	Three-dimensional
1G	First generation mobile telephony
2G	Second generation mobile telephony
2.5G	Second and a half generation mobile telephony
2.75G	Enhanced data rates for GSM evolution
3G	Third generation mobile telephony
3.5G	Fourth generation mobile telephony
4G	Fourth generation mobile telephony
5G	Fifth generation mobile telephony
6G	Sixth generation mobile telephony
ABFinTechs	Brazilian Fintech Association (Brazil)
ADAS	Advanced driver assistance system
AFD	French Development Agency (France)
AFSCA	Federal Authority for Audiovisual Communication Services (Argentina)
AFTIC	Federal Authority for Information and Communications Technologies (Argentina)
AI	Artificial intelligence
ALC	Active leakage control
AMHS	Automated message handling system
AMPS	Advanced mobile phone service
ANATEL	Agência Nacional de Telecomunicações (Brazil)
API	Application programming interface
AR	Augmented reality
ARPA	Advanced Research Projects Agency (USA)
ARPANET	Advanced Research Projects Agency Network (USA)
ARSAT	Argentina Soluciones Satelitales S.A. (Argentina)
AT&T	AT&T Incorporated (USA)
ATM	Automated teller machine
AV	Autonomous vehicle
AVL	Automatic vehicle location
BaaS	Backend as a Service
BANDES	Banco de Desenvolvimento do Espírito Santo (Brazil)
BI	Business intelligence
BIM	Building Information Modeling
BIRF	International Bank for Reconstruction and Development

BNDES	Brazilian National Development Bank (Brazil)
BPL	Broadband over power lines
BRL	Brazilian real
BRT	Bus Rapid Transit
BS	Broadcast satellite
CAB	Civil Aeronautics Board
CADE	Council for Economic Defense (Brazil)
CAF	Corporación Andina de Fomento
CAFSAT	Central Atlantic Flight Information Region
CAGR	Compound annual growth rate
CAPEX	Capital expenditure(s)
CATI	Committee of the Area of Information Technology (BR)
CCA	Combinatorial clock auction
CCTV	Closed-circuit television
CDMA	Code Division Multiple Access
CEATSA	Centro de Ensayos de Alta Tecnología (Argentina)
CERT-PY	Centro de Respuestas ante Incidentes Cibernéticos (Paraguay)
CHESF	Companhia Hidroelétrica do São Francisco (Brazil)
CIA-A	Centro de Inteligência Artificial em Agroenergia (Brazil)
CIC	Centro Integrado de Controle Multiserviços
CISCEA	Comissão de Implantação do Sistema de Controle do Espaço Aéreo (Brazil)
COE	Center of Excellence
CoE-Tap	Centers of Excellence – Telecom Phase
COFEFUP	Federal Council of the Public Function
COMAER	Comando de Aeronáutica (Air Force Command - Brazil)
COMPR.AR	National Public Administration procurement platform (Argentina)
CONATEL	Comisión Nacional de Telecomunicaciones (Paraguay)
CONFEMECO	Federation of Collegiate Medical Entities (Argentina)
CONTRAT.AR	Electronic management system for public works contracts and concessions (Argentina)
CO2	Carbon dioxide
CORASA	Correo Argentina (Argentina)
COSERN	Companhia Energética do Rio Grande do Norte (Brazil)
COSIP	Contribuição do Serviço de Iluminação Pública (Brazil)
COVID-19	The illness caused by the SARS-CoV-2 virus
CPF	Cadastro de Pessoas Físicas (Brazil)
CPQD	Centro de Pesquisa e Desenvolvimento em Telecomunicações (Brazil)

C-RAN	Centralized radio network
CSS	Chirp spread spectrum
CT	Computed tomography
DAMI	Metropolitan Area Development Program (Argentina)
DARPA	Defense Advanced Research Projects Agency (USA)
DAT	Agro-technological district (Brazil)
DCOI	Data Center Optimization Initiative (USA)
DMA	District metered area
DPAPM	Division of Public Administration and Development Management (United Nations)
DRBC	Disaster recovery/business continuity
DSL	Digital Subscriber Line
DTT	Digital terrestrial television
DWDM	Dense wavelength division multiplexing
EDGE	Enhanced data rates for GSM technology
EEG	Electroencephalogram
e.g.	For example
EGDI	e-Government Development Index
HER	Electronic health record
eMBB	Enhanced mobile broadband
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuària (Brazil)
EMR	Electronic medical record
ENACOM	Ente Nacional de Comunicaciones (Argentina)
ePHR	Electronic portable health record
ES	Espirito Santo (Brazil)
ESC	Emerging and Sustainable Cities Program
Eurocontrol	European Organization for the Safety of Navigation Aviation
EV	Electric vehicle
EVDO	Evolution Data Optimized
FAA	Federal Aviation Administration (USA)
FDNE	Northeast Development Fund (Brazil)
FEBRABAN	Brazilian Federation of Banks (Brazil)
FEED	Front-end engineering design
FIFA	Fédération Internationale de Football Association
FIR	Flight Information Region
FNDCT	National Fund for the Development of Science and Technology (Brazil)

Fonplata	Fondo Financiero para el Desarrollo de los Países de la Cuenca del Plata
FS	Fixed satellite
FUNTTEL	Fundo para o Desenvolvimento Tecnológico das Telecomunicações (Brazil)
Gbps	Gigabytes per second
GDP	Gross domestic product
GDPR	General Data Protection Regulation (European Union)
GEO	Geosynchronous equatorial orbit
GHz	Gigahertz
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für International Zusammenarbeit (Germany)
GPRS	General Packet Radio Service
GPS	Global positioning system
GRCIC	Gestão das Redes de Comunicações Integrada do COMAER (Brazil)
GSI	Institutional Security Office of the Presidency of the Republic (Brazil)
GSM	Global System for Mobile Communications
HCI	Human Capital Index
HD	High definition
HFT	High-frequency trading
HSPA	High-Speed Packet Access
HTTPS	Hypertext Transfer Protocol Secure
HVAC	Heating, ventilation and air conditioning
IaaS	Infrastructure as a Service
IBGE	Brazilian Institute of Geography and Statistics (Brazil)
IBM	International Business Machines Corporation (USA)
ICI	Instituto das Cidades Inteligentes (Brazil)
ICT	Information and communications technology
ICU	Intensive care unit
IDB	Inter-American Development Bank
IFI	International financial institution
IoT	Internet of Things
INFRAERO	Empresa Brasileira de Infraestrutura Aeroportuária (Brazil)
INVAP	INVAP S.E. (Argentina)
iOS	Apple mobile operating system (originally iPhone operating system)
IP	Internet Protocol
IPEA	Instituto de Pesquisa Econômica Aplicada (Brazil)

ISP	Internet service provider
ISRO	Indian Space Research Organization (India0
IT	Information technology
ITU	International Telecommunication Union
IXP	Internet exchange point
JAMA	Journal of the American Medical Association
JRT	JR Telecommunicações (Brazil) or JRT Business Group (USA)
Kg	Kilogram
Km	Kilometer
Kbps	Kilobytes per second
kW	Kilowatt
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LEO	Low earth orbit
LGPD	Brazilian General Data Protection Law (Brazil)
LLC	Limited liability corporation
LoRa	Long range
LTE	Long-Term Evolution
MAN	Metropolitan area network
MAPA	Ministério da Agricultura, Pecuária e Abastecimento (Brazil)
Mbps	Megabytes per second
MCI	MCI Inc. (now Verizon Communications, Inc.) (USA)
MCTIC	Ministério da Ciência, Tecnologia e Inovações (Brazil)
MDPI	Multidisciplinary Digital Publishing Institute
MDR	Ministry of Regional Development (Brazil)
MEC	Ministério de Educação (Brazil)
MEO	Middle earth orbit
MGS	Municipal Government of Salta (Argentina)
m-Health	Mobile health
MHz	Megahertz
MIMO	Multiple input/multiple output
MITIC	Ministerio de Tecnologías de la Información y Comunicación (Paraguay)
mMTC	Massive machine-type communications
MoH	Ministry of Health (Argentina)

MQTT	Message Queuing Telemetry Transport
MS	Mobile satellite
MSAS	Ministry of Health and Social Action (Argentina)
MSPyB	Ministerio de Salud Pública y Bienestar Social (Paraguay)
NASA	National Aeronautics and Space Administration (USA)
NAV Brasil	Brazilian Navy (Brazil)
NDB	New Development Bank
NMT	Nordic mobile telephony
NOC	Network operations center
NOMA	Non-Orthogonal Multiple Access
NTT	Nippon Telephone and Telegraph (Japan)
OASC	Open and Agile Smart Cities
OECD	Organization for Economic Cooperation and Development
OEE	State agencies and entities (Paraguay)
OMA	Open Mobile Alliance
OMA	Orthogonal Multiple Access
OSI	Online Service Index
OTT	Over-the-top (telecommunications providers)
PaaS	Platform as a Service
PAHO	Pan American Health Organization
PGSA	Argentine Geostationary Satellite Plan (Argentina)
PHR	Portable health record
PIDUA	Salta Province Urban Environmental Development Program (Argentina)
PoP	Point of presence
POS	Point of sale
PPP	Public-private partnership
PRODAP	Centro de Gestão da Tecnologia da Informação (Brazil)
PRODEST	Instituto de Tecnologia da Informação e Comunicação do Espírito Santo (Brazil)
PTI	Parque Tecnológico Itaipu (Brazil)
PTZ	Pan-tilt-zoom
PV	Photovoltaic
Q1,2,3,4	First, second, third or fourth quarter of a year
R&D	Research and development

REFEFO	Red Federal de Fibra Óptica (Argentina)
RES	Emissions Reduction Project (Argentina)
RFS	Ready for service
RNP	National Education and Research Network (Brazil)
RTCAER	Rede Telefônica de Comando do Comando da Aeronáutica (Brazil)
RTT	Real-Time Text
RUTE	Rede Universitária de Telemedicina (Brazil)
SaaS	Software as a Service
SAOCOM	Satélite Argentino de Observación con Microondas (Argentine earth observation satellite constellation)
SCCC	Smart cities control center
SCD	Satellite(s) for collection of data
SDG	Secretariat for Digital Government (Brazil)
SDG	Sustainable development goal
SDI	Secretary of Infrastructure Development (Brazil)
SDM	Spatial digital multiplexing
SD-WAN	Software-defined wide area network
SEAD	Secretaria de Estado de Administração (Brazil)
SEI	Electronic Information System (Brazil)
SEPEC-ME	Special Secretary of Productivity, Employment, and Competiveness (Competitivity) - Ministry of Economy (Brazil)
SG1	Second generation-1 (satellite)
SGDC	Geostationary Defense and Strategic Communications Satellite
SICOTAN	Sistema de Cobrança das Tarifas de Uso das Communicações e dos Auxilios à Navegação Aérea em Rota (Brazil)
SIGA	Sistema Integrado de Informações Geográficas (Brazil)
SNIS	Sistema Nacional de Informações sobre Saneamento (Brazil)
SOC	Security operations center
SPV	Special purpose vehicle
SRM	Sub-secretary of Regulation and Markets (Brazil)
SSGDC	Satellite(s) for strategic and defense communication
SUBAST.AR	Transactional platform to auction off public sector assets that are no longer required in service (Argentina)
SUDENE	Superintendency for Northeast Development, Ministry of Regional Development
SUS	Unified Health System (Brazil)
T1	T carrier-1 (digital transmission line)
TACS	Total Access Communication System
TAI	Turkish Aerospace Industries (Turkey)

TB	Terabyte
Tbps	Terabytes per second
TBR	Telessaúde Brasil Redes (Brazil)
TDMA	Time division Multiple Access
TELESAT	Canadian satellite communications company (Canada)
TF-2	Team fortress-2 phone network
TF-3	Team fortress-3 phone network
THz	Terahertz
TII	Telecommunication Infrastructure Index
TIM	Telecom Italia Mobile (Italy)
TV	Television
TVRO	Television receive only
UAB	Universidade Aberta do Brasil (Brazil)
UAV	Unmanned aerial vehicle
UCLA	University of California - Los Angeles (USA)
UERN	Universidade Estadual do Rio Grande do Norte (Brazil)
UFRN	Universidade Federal do Rio Grande do Norte (Brazil)
UID	Unique identifier
UMTS	Universal Mobile Telecommunications System
UN	United Nations
UN-DESA	United Nations - Department of Economic and Social Affairs
UN-ITU	United Nations International Telecommunication Union
UPS	Uninterruptible power supply
URLLC	Ultra-reliable and low-latency communications
US	Ultrasound
U.S.	United States (of America)
USA	United States of America
USB	Universal serial bus
USTDA	United States Trade and Development Agency
v1.0	Version 1.0
VAT	Value-added tax
VoIP	Voice over internet protocol
VR	Virtual reality
VSAT	Very-small aperture terminal
WAN	Wide area network

WHO	World Health Organization
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WING	Worldwide IoT Network Grid
WRI	World Resource Institute
YPF	YPF S.A. (Argentina)
Y-TEC	YPF Tecnologia, the YPF research and development division (Argentina)